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APPLICATIONS FOR MEMBERSHIP SHOULD BE ADDRESSED TO THE EXECUTIVE SECRETARY

Speech Habilitation in Cerebral Palsy

• *Shirley E. Hoberman*

• *Morton Hoberman*

The increasing interest in cerebral palsy and the research and exploration now being carried on all over the world has led to some exciting advances in the basic concept of this neuromuscular disorder, as well as in the education and treatment of the cerebral palsied patient. It is the purpose of this paper (1) to summarize some of these newer methods of treatment and (2) to suggest means of utilizing those that may be of value to the speech clinician working with cerebral palsied children. We shall also review briefly a few 'older' techniques which we use in our comprehensive speech and language program. It is not our intention to give a definitive program of treatment for any particular child or group of children. Rather, we are suggesting that interested clinicians learn the various techniques to be discussed, and the rationale behind them, so that they may be adapted for speech habilitation when and if they seem appropriate and relevant to a therapy program.

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Speech and/or language deviations occur in most cerebral palsied children. Visual and auditory deficits, delayed or uncertain laterality or dominance, and poor visual motor coordination are often contributing or accompanying factors in the faulty speech development of these children. It is important that the clinicians concerned with speech habilitation of the cerebral palsied keep in mind the sensory as well as the motor deficits with which they are coping. In children with aphasia, or, as Strauss (*12*) suggests, 'oligophasia,' we must frequently deal with deviations in perception and symbolization as well as with neuromuscular deficits of the speech mechanism.

Multiple Involvements

It is the rare cerebral palsied child who is a pure spastic, athetoid or ataxic. Most children are predominantly one type insofar as their general motor picture is concerned, but they usually include some elements of the other groupings as well. The predominant neuromuscular findings in the spastic child are hyperactive tendon reflexes, the presence of a 'stretch reflex' in some or all muscles, and the impairment of voluntary control of motion. When these aberrations are present in the musculature of the head, neck, mouth, face and chest, speech is usually abnormal.

Breath control, especially expiration, is usually poor. Reciprocal tongue movements are impaired or absent, producing distortions and inaccuracies in articulation. Rate of speech varies, being either extremely slow or explosive, while volume and pitch are uncontrolled. This is what is usually referred to as 'cerebral palsied' speech. Many hemiplegic and diplegic children have essentially normal speech.

The dyskinetic child, most usually an athetoid, has, as his primary motor dysfunction, the presence of involuntary, uncontrolled movements of varying extent, degree and location. While there is no 'stretch reflex,' or hyperactive tendon reflex, these children frequently develop 'tension' in certain muscle groups in their effort to control the involuntary movements. Speech in these children is extremely variable. The mildly afflicted child may show only slight articulatory disturbances, while the severely involved child may be completely mute (*1*). Speech rhythm and phrasing are frequently distorted due to irregular breathing patterns. Tongue tip elevation is characteristically inhibited in these youngsters, thereby distorting most consonant sounds. Lack of control of head movement, especially extension and rotation, produces hypertonicity of the laryngeal musculature resulting in a tense, throaty, dysphonic voice. Excessive drooling, inhibition of swallowing, and inadequate mouth closure, which are frequently found in these children, contribute to their speech problems.

The ataxic child is usually incoordinated and arrhythmic. Speech is slurred and uncertain. His voice is usually dull and monotonous or has abnormal variations in volume and pitch. These characteristics probably result from the inability to coordinate the various muscle groups responsible for volume, pitch and articulation.

While the problems posed by the various abnormalities listed above are of major magnitude insofar as speech habilitation is concerned, they are but part of the picture. Unless we take into consideration the 'whole' child, his personality, his relationships at home and at school, his emotional and intellectual status, as well as his total physical involvement, our efforts at speech habilitation may fail or fall short of the desired goal, despite intensive and well-prescribed therapy. We must also remember that cerebral palsy, in addition to being a symptom-complex rather than a disease, is usually static and not progressive in nature. Such improvement as is possible can be made only through control of abnormal patterns of motion and movement.

Early Evaluation

Speech habilitation should be instituted as early as possible in these children. It is much easier to prevent than to correct poor speech habits. If it were possible to counsel the parents of cerebral palsied infants insofar as feeding methods and speech and language stimulation are concerned, our task would be an easier one. Unfortunately, even when the diagnosis of cerebral palsy is made before one year of age, the child is rarely referred for speech evaluation before the second or third year. By this time, the mother of the child who had difficulty in sucking had literally poured the milk into his mouth and, if he had trouble swallowing, had tilted his head back so as to allow gravity to assist him (*9*). Children who had diffi-

culty manipulating a bolus of food within their mouths were frequently kept on soft baby foods which were placed on the backs of their tongues for easier swallowing. Here were the beginnings of problems with oral musculature. These children had no need, in the supine position, to establish firm lip closure in order to keep liquid and food within their mouths, or to suck vigorously on a nipple to pull milk from a bottle. With food placed on the back of the tongue, it was unnecessary for them to attempt to maneuver the tongue in order to propel food from the front to the back of the mouth for swallowing. The combination of poor lip closure and deficient tongue movement results in drooling and lack of stimulation of the swallowing reflex. The growth and voluntary control of oral musculature is dependent upon its constant utilization in the prespeech movements of sucking, chewing and swallowing (*9*).

Frequently the empathic relationship between the cerebral palsied child and his mother has developed so thoroughly that speech is not essential. The mother anticipates and meets her child's every need without verbal language of any kind between them. Speech and language development are inhibited because the necessary frustration and stimulation are absent. These children have no need for vocalization or purposeful speech. Such a child's surroundings frequently remain circumscribed, his social relationships extremely limited, and consequently there is very little stimulation for speech development. Clinicians must be prepared in many instances for long periods of intensive treatment with these patients, involving language stimulation, extensive muscle education, and the building of new neuromuscular response patterns.

New Techniques

The newer techniques presently being used and evaluated in the field of physical therapy and, to a lesser extent, in occupational therapy for the treatment of the cerebral palsied child are based on concepts of neurological deficits resulting in the persistence of abnormal reflex patterns and abnormal neuromuscular patterns of movement. In general, it has been our feeling that each of the various methods to be described has distinct merit, provided that there is proper selection of the patient and the technique to be used with that patient.

In all these techniques there is an awareness of the imbalance of inhibition and facilitation, the deficient or inappropriate response to proprioceptive stimuli, and the deficient sensory self-regulatory feedback mechanisms. Each technique actually attempts to restore all these imbalances and deficiencies but usually stresses one factor over the other two as being the more important.

For the Bobaths (*2*), the inhibition of the abnormal, tonic neck and labyrinthian reflexes is most important. Hence, their primary concern is with the development of proper positions and attitudes which inhibit these abnormal states. When a proper position is found, an attempt is made to teach the child to stay in that position. Later the child is taught how to move into the 'inhibiting' attitude. During these various stages certain proprioceptive stimuli (rocking, shaking) are used to further enhance the desired inhibition

FIGURE 1. 'Tension' athetoid with tonic hyperextended neck and head, and open mouth.

FIGURE 2. Adaptation of the Bobath 'reflex-inhibiting' position. Reversal of abnormal extension reflex to one of flexion.

FIGURE 3. Patient maintains flexed position without assistance while vocalizing 'hold it.'

of abnormal reflex patterns (*11*). In some instances 'tapping' is performed to facilitate joint movement, possibly by increasing muscle tone (*2*). We are especially interested in the child with a tonic, hyperextended neck and head, with or without rotation, who has resultant increased tension in the laryngeal area and, frequently, an open mouth. Such a child is seen in Figure 1. If the basic abnormal reflex is one of extension, the clinician will gradually reverse this over-all pattern to one of reflexion, as seen in Figure 2. Inhibition, it is felt, occurs when the entire body relaxes, hypertonus subsides, and the child becomes comfortable and adjusted to the new posture. Gentle rocking or shaking movements are sometimes used to help the patient adjust to, and become comfortable in, the new position. After relaxation (inhibition of hypertonus) has taken place, the patient is gradually taught to stay in this position by himself (*11*). When relaxation of the neck and throat has been attained and any jaw deviation relieved by these methods, the speech clinician works for mouth closure and easy, relaxed phonation. The mouth may be held closed to insure nasal breathing and to facilitate bilabial consonant formation. Some clinicians work from here on isolated sound formation (*8*), but we have found meaningful speech more apt to provide carry-over in these children. The patient learns, gradually, to recognize, meet and control hypertonicity in various parts of the body, including the speech musculature. This technique has proven especially helpful with patients who have spasticity and hyperextension in the upper trunk, neck and laryngeal area. Breathing difficulties are sometimes overcome by the clinician 'vi-

brating' on the diaphragm, ribs, spine, upper chest and/or larynx, depending upon the particular breathing difficulties of the patient (*8*).

When the 'reflex inhibiting' posture can be maintained for a suitable period of time, we proceed with training in sustained phonation with vocalization, usually with an ease that was heretofore impossible. The patient in Figure 3 is shown maintaining a flexed posture without aid as she vocalizes 'hold it.' Mrs. Bobath stresses that, before any teaching can be done under these conditions, the child must learn voluntarily and consciously to assume normal positioning. This, she emphasizes, is not mere relaxation but deliberate conscious inhibition of abnormal attitudes.

Proprioceptive neuromuscular facilitation techniques used by Kabat and Knott (*6*) have been helpful in obtaining control of desired patterns of movement. These techniques utilizing mass movement patterns have been defined as 'methods of promoting or hastening the response of the neuro-muscular mechanism through stimulation of the proprioceptors' (*6*). Proprioceptive stimuli, such as stretch, maximal resistance, pressure, traction, and patterns of coordination of synergistic muscles, are used for the development of movements which approximate the normal. Kabat states that the motor cortex, the spinal cord and subcortical motor centers are stimulated by these techniques. Resistance applied to motions of the lateral chest walls, upper chest, sternum and diaphragm stimulate the muscles of respiration and make for increased range of motion of the chest. Stimulation of the diaphragm involves 'placing the hands along the costal cartilages of

FIGURE 4. Patient is encouraged to elevate or protrude her tongue without success.

FIGURE 5. Resistance is applied to tongue protrusion. Patient is instructed to push her tongue out and up as the clinician resists this movement.

FIGURE 6. Clinician is resisting patient's attempt to flex her neck and rotate it to the left.

FIGURE 7. Patient has succeeded in flexing her neck and rotating her head to the left against resistance.

the lower ribs. Pressure and stretch is applied with the thumbs pushed up and under the rib cage as far as possible without producing pain' (7). Other techniques such as rhythmic stabilization are also used to stimulate the diaphragm.

Mouth opening was found to be related to neck flexion patterns and mouth closing to neck extension. In order to facilitate these mouth movements, the clinician uses neck flexion and extension against resistance. Neck flexion also reinforces elevation of the tongue, and neck extension reinforces depression of the tongue. The patient in Figure 4 was unable to protrude or elevate her tongue upon request. To strengthen tongue protrusion and elevation, the clinician may grasp the tongue with a piece of gauze and push back and downward, instructing the patient to pull it back. Then the patient is instructed to push his tongue out and up as the clinician resists this movement (Figure 5). This instruction is repeated as the effort is sustained. The patient with a hyperextended, rotated head is given resistance to a voluntary motion which places the head in the opposite direction to that in which it is habitually held. In Figure 6 the clinician is resisting the patient's attempt to flex her neck and rotate it to the left. In some instances where a strong contraction is thus obtained in the desired muscles, relaxation occurs in the spastic muscles, allowing for a more normal positioning of the head and neck and a resultant readiness for relaxed phonation and speech training (7). In Figure 7 the patient has succeeded in flexing her neck and rotating her head to the left against resistance.

Some of Rood's therapeutic tech-

niques are used to provide proprioceptive stimuli for the establishment of proper breathing patterns and for the stimulation of tongue and velar action (*10*). A cube of ice placed in an area above the diaphragm may produce a change of breathing patterns from the thorax or clavicular region to that of the diaphragm by causing contraction of the diaphragm and reciprocal relaxation of the abdomen. The effect is short-lived but sometimes long enough to give the patient the kinesthetic feel of a normal breathing pattern. Gentle stroking of isolated areas on the surface of the tongue or velum, using either the finger or a small, dry paint brush (*10*), will often stimulate these areas to respond appropriately.

Older Techniques

The speech clinician, working with the physical therapist, may carry out a prescribed program of general relaxation, aimed at release from spasticity or involuntary motion, and a growing awareness and subsequent control of neuromuscular response patterns. The patient is taught to meet and deal with involuntary movement and spasticity which interfere with speech just as they interfere with physical activity. Passive relaxation techniques are sometimes used wherein the child is instructed to 'let go' as the clinician rotates his head from side to side and opens and closes his mouth until abnormal responses are quieted. We are interested, during this maneuver, in the sternocleidomastoideus, and platysma muscles, among others, which in the cerebral palsied child are oftentimes tense and/or spastic and produce clavicular breathing (*3*). Such breathing is shallow and irregular, making for a gasped tone which is unsustained and weak, and speech that is dysrhythmic. We may also be concerned with the suprahyoid and infrahyoid muscles which change the position of the hyoid bone. When these muscles are spastic or tense, they bring about corresponding spasticity and tension in the larynx and base of the tongue. This condition is the basis for the rasping, breathy voice seen in so many patients. Tension at the base of the tongue will not allow for tongue tip mobility. Hence, we have one of the contributing causes of poor tongue tip action, so necessary for accurate articulation. If we can attain relaxation and release from spasticity in these muscles by passive movement, we can provide our patients with a mental concept of the muscle 'set' we are attempting to achieve.

So often we see the uncontrolled spasticity of the masseter muscle resulting in a tightly clamped jaw, or spasticity of the supra and infra hyoids, the platysma and lateral pterygoids causing a widely opened and, sometimes, locked jaw. Too wide a mouth opening causes hypertension in the throat area, and we therefore concentrate upon relaxation of the involved muscles, followed by assisted raising of the mandible. Assistance can be decreased as the patient begins to take over and the muscle begins to function more normally. Emphasis is then placed upon gradation of mouth opening and closure. Throughout this type of therapy the formula is 'let go' as the therapist puts the muscles through a passive range of motion, 'feel it' as we urge the child to become kinesthetically aware of what we are doing, 'help me' as we attempt to stimulate

FIGURE 8. Patient wearing a chin cradle to limit mouth opening and tongue thrust.

voluntary movement and control and, finally, 'take over' or 'hold.'

Progressive relaxation as taught by Jacobson (*5*) is sometimes helpful. Relaxation is attained by first achieving a forceful contraction against resistance of the jaw muscles or of the neck for about four or five seconds, followed by complete relaxation for five-to-10 seconds. This contrast from forceful contraction increases the consciousness of complete relaxation in a muscle or group of muscles.

Some of the techniques proposed by Westlake (*14*) years ago are still proving useful. A rubber block is placed between the teeth of a subject who cannot voluntarily tighten his lips. If he is asked to bite hard upon this block, his lips will involuntarily tighten, providing the patient again with the kinesthetic sensation of firm lip closure. A chin cradle strapped to a headband (Figure 8) limits mouth opening in patients who with any voluntary effort fling their mouths widely open and thrust out their tongues. This device helps to break up accessory tongue movements and facilitates learning of useful tongue, jaw and lip patterns.

OTHER PROBLEMS

In children with aphasia or 'oligophasia' (*12*), we must frequently deal with deviations in perception (other than auditory) and symbolization as well as expression. These children are best handled by taking into consideration the specific problem presented. Some must be taught by a single sensory approach that is amplified instead of a multisensory approach. Others must be trained in visual motor coordination concurrently with speech. A quiet room, free from extraneous noise and visual stimuli is a necessity for some of these youngsters. Occasionally it helps to darken the room somewhat in order to minimize the play of light and shadow which proves so distracting to these easily stimulated patients. Soft music or children's records made for relaxation purposes are sometimes used with good results. Playing 'rag doll' or 'floppy pooch' with the children is an older, but still serviceable, method for release and relaxation.

Along with the occupational therapist, the speech clinician evaluates the feeding problems and the resultant oral inadequacies which some of these children present. Sucking, chewing and swallowing are processes that must be mastered for nutritional as well as for speech purposes. A child must use his lips, tongue and jaw for feeding pur-

FIGURE 9. Spontaneous laughter reducing tension and spasticity in a group of cerebral palsied children.

poses before he can use them for speech. Tubing of various thicknesses is used for drinking as the child is gradually raised from the reclining to the upright position in order to stimulate sucking and swallowing. The amount of fluid in the tubing is regulated by the therapist as she places her thumb against the distal end of the tube, gradually increasing the flow of liquid and forcing the child to cope with swallowing larger and larger amounts.

If we place a child on his stomach and feed him small pieces of biscuits or cookies, we set up a struggle situation wherein the child must learn to keep his lips closed to keep the desired food within his mouth. He must also learn to use his tongue to propel the food to the back of his mouth in preparation for swallowing, and then he must swallow it against gravity. A mirror placed below his face is sometimes helpful in establishing direction and placement. Drooling is usually alleviated with the establishment of good feeding habits.

With some children who have never spoken or phonated voluntarily before, it is necessary to produce phonation, at first involuntarily by means of reflex stimulation, then purposefully, and to follow it with babbling. A gentle massage or vibratory movements on the chest will produce changes in pitch and volume which amuse and stimulate the child to further voluntary vocalization. Once babbling has been established and is spontaneous and pleasurable, we proceed to speech and language stimulation.

There are some linguists who feel that babbling is of no value other than as an exercise for physiological non-speech functions and that the echolalic

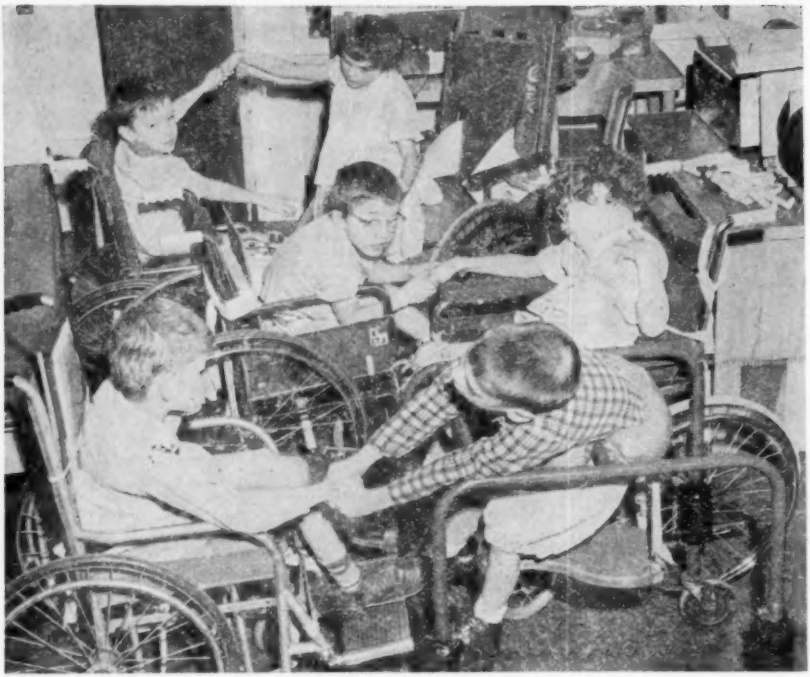

FIGURE 10. 'Swing up and down.' Use of rhythmical body activity in conjunction with speech training.

stage that follows is merely an advanced form of babbling (*13*). They feel it has only a physiological, vegetative function and is not a precursor to speech. Others feel that it is a necessary vocal play before the selective use of sounds and speech can be evoked. Whatever its function, since it is vocal play and pleasurable for most children, thereby increasing rapport with the clinician, we find it useful in our training program.

Training in isolated vowel and consonant formation is still used by many workers in the field; but others have found it worthless, mainly because it is meaningless to the child as far as speech and language are concerned. We proceed, instead, to intensive stimulation of language and speech in meaningful situations. The child is exposed to rhymes, songs and stories, at first without demands for any response on his part. If these rhymes or stories are structured to produce spontaneous laughter in the child, so much the better. Such laughter, it is found, occurs without spasticity and is quite frequently followed by intelligible utterances. The spontaneous chuckle is not to be confused with the gasped laughter produced with a startle stimulus or by spasticity. It is a relaxed, hearty chuckle which puts the child at ease and re-

duces the tension usually brought about, unwittingly, in therapy situations (*4*). The children in Figure 9 are demonstrating this relaxation quite effectively.

Group Work

As the child becomes accustomed to the speech setting, either individually or in groups, we frequently find attempts at voluntary response. We use jingles, rhymes and songs with short, simple choruses which are repeated many times throughout the rhymes. We have found this one of the best ways of inducing a spontaneous response from the child as he attempts to join in the chorus. A great deal of praise and encouragement at this point will lead to further attempts and better performance. We try to use material that will encourage some bodily activity (swinging an arm or leg, rocking back and forth, holding up a hand at timed intervals, or waving) to promote easy, relaxed phonation and support of tone, with the child's attention directed away from the sound producing mechanism and toward the rhythmical body activity. Children love music and songs, and we have found it much easier to encourage tongue tip elevation by substituting 'la' for the words of a song than by tongue exercises and phonetic drill. Although some children will work hard and eventually accomplish the necessary tongue elevation for scraping peanut butter or soft fudge from the hard palate, they find it difficult to associate this activity with verbalization. We therefore do most language and speech training in a situational setting where the child sees the need and relevancy of speech. The cerebral palsied child in the controlled group setting will in time begin to feel that he 'belongs' and that his participation is not only necessary but pleasurable. The group provides ample opportunity for the recommended use of rhythmical body activity in conjunction with speech. Even children in wheelchairs or walkers can 'row, row, row their boats,' 'pull brass rings on the merry-go-round,' 'pick up paw paws and put 'em in their pockets,' or with partners 'swing up and down' till they 'reach the sky' (Figure 10). More restricted, finer movements accompany such songs as 'Open, shut them. Open, shut them. Give a little clap,' or 'Let everyone clap hands with me.' We try to instill in these patients a feeling of need for speech. Without it, speech training is worthless. However, even if this need is present, and speech training goes undirected, it ends in frustration.

In each session it is important that the patient have some measure of success. Careful planning by the clinician which provides the optimum amount of stress and sets suitable subgoals that are just within the child's physical and mental capacities will accomplish this success and give the child the impetus and desire to meet new goals and standards. It is also the function of the clinician to teach the patient to compensate in speech for other deficiencies and to help find ways and means, however unorthodox, to make his speech understandable. Our own goals must be closely scrutinized in view of the limitations of the patient with whom we are working.

A great deal of study and observation on the part of the specialist team is necessary to determine the approaches to habilitation that will be most fruit-

ful. Differential diagnosis is difficult but certainly most crucial to proper treatment. We must, as clinicians, exercise a great deal of self-discipline in the setting of our goals in order to avoid pushing these youngsters beyond their capacities. On the other hand, it is essential to language learning that a certain amount of frustration be imposed. It is only by careful observation and study of each child, in consultation with other specialists, that a suitable program of habilitation can be set up. It is imperative to our efforts on behalf of these children that speech be made a desired skill that will serve their needs, channel their frustrations and make of them active, participating members of their environment.

Self-discipline, ingenuity and optimism are invaluable assets to the clinician working with the speech disabled, cerebral palsied child. Speech taught by rote in isolated, meaningless situations has never been too successful and our entire program should take place in situations in which this learned skill will be used when our patients leave us.

Summary

A brief description of the speech deviations found in cerebral palsied children is presented. Some of the contributing causes of disturbed speech and language, including neuromuscular deficits, poor feeding habits and inadequate speech and language stimulation, are discussed. Some habilitation techniques and 'method treatments' now in use at the New York State Rehabilitation Hospital at West Haverstraw, New York, are described and illustrated. Included in these are adaptations of the Bobath 'reflex inhibiting' postures; the Kabat proprioceptive, neuromuscular facilitation techniques; Rood's sensorimotor techniques; general relaxation methods; Jacobson's progressive relaxation; and some of Westlake's techniques and stabilization methods. Perceptive and expressive failures are taken into account and suggestions for dealing with them are given. Feeding problems and methods of handling them are discussed. Means of language stimulation, including choral work, rhymes, jingles and songs, are reviewed as well as the use of accompanying body activity. The desirability of early evaluation is stressed. A realistic and comprehensive approach to speech habilitation is advocated and clinicians are urged to plan programs that are both satisfying and motivating to the patient.

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Language and Mentation of Two Phenylketonuric Children

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Phenylpyruvic oligophrenia was first described by Følling (*9*) in 1934 and was soon recognized as representing an inborn error of metabolism. It occurs approximately once in every 25,000 births and is transmitted as a simple Mendelian recessive trait. The disease commonly results in severe mental retardation. The less cumbersome name phenylketonuria was proposed by Penrose and Quastel (*18*) in 1937, and is now widely used. In 1947, Jervis (*12*) suggested that the metabolic error consisted of a blockage of the conversion of phenylalanine into tyrosine; the unmetabolized amino acid would then accumulate in the body fluid and be excreted as such or as its deaminated products, phenylpyruvic, phenyllactic and phenylacetic acid. In 1953, Jervis (*13*) confirmed the validity of this hypothesis by demonstrating the absence from the liver of the enzyme which normally catalyzes the oxidation of phenylalanine to tyrosine. Clinically, these children are very frequently blonde and blue-eyed, have eczematoid skin eruptions and a disagreeable pungent body and urine odor. Except for the signs and symptoms of mental retardation, the neurological examination is generally within normal limits.

In spite of this exact knowledge of the metabolic error, no information is yet available concerning the exact pathogenesis of this condition. No correlation has been found between the levels of phenylalanine or its deaminated products and the degree of mental retardation. The pathology of the disease is still not understood although indications are that faulty myelinization may play a major role in the cerebral defect (*19*). Even though uniformly high levels of serum phenylalanine could not be demonstrated to have a direct toxic effect upon the brain, the dietary experiments with phenylalanine-low diets first reported (*2*, *4*, *10*, *20*) have led to widespread use of this method in attempts to correct, or better, to prevent, the mental retardation so frequently observed in this disease.

Many reports of such studies (*1*, *3*, *5*, 7, *10*, *11*), in addition to the four already mentioned, have so far yielded somewhat heterogeneous results. In gen-

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TABLE 1. Results of repeated electroencephalograms of two phenylketonuric children.

Date	*EEG Results*
A.N. (Born March 26, 1953)	
Aug. 31, 1956	Some slow wave and slow spike-like wave abnormalities in both temporal lobes with a right preponderance. IMP: Abnormal EEG with a suggestion of a right temporal focus.
Oct. 30, 1956	Essentially unchanged, but the focal abnormality is less well marked. IMP: Abnormal EEG.
April 5, 1957	Shifting temporal slow wave abnormality of questionable significance. IMP: Probably normal EEG.
Nov. 14, 1957	Shifting slow waves in temporal areas, perhaps slightly more on the right; Questionable significance. IMP: Borderline EEG.
May 1, 1958	Persistence of mild left-sided slow wave abnormality. IMP: Mildly abnormal EEG.
Nov. 12, 1958	Normal EEG.
Dec. 28, 1959	Random slow activity bilaterally. Single synchronous bilateral burst of higher voltage four cps activity. IMP: Mildly abnormal EEG.
S.N. (Born April 6, 1954)	
Oct. 30, 1956	Good pattern considering child's age. There is a suggestion of a slow wave focus in the left temporal area. IMP: borderline EEG.
April 5, 1957	Persistence of mild left temporal-parietal asymmetry which may represent a focal abnormality. IMP: Borderline EEG.
Nov. 14, 1957	A few suspicious looking spike discharges appear in the right temporal region. IMP: Possibly abnormal EEG.
May 1, 1958	Definite left fronto-temporal slow spike focus. IMP: Abnormal EEG.
Nov. 12, 1958	Very mild left fronto-temporal slowing. IMP: Borderline EEG.
Dec. 28, 1959	Some spike-like discharges and abnormal slowing on both sides with left fronto-temporal predominance. IMP: mildly abnormal EEG.

eral, however, there is agreement that restriction of phenylalanine intake in the child under two years of age may result in greater clinical improvement than similar improvement in the older child (*21*). It is now well recognized that the disease may vary considerably in its clinical manifestations, including the level of intelligence (*17*, *21*). The disease is difficult to recognize clinically, and the diagnosis can only be made on the basis of a positive urinary test for phenylpyruvic acid or by the more difficult determination of serum phenylalanine tests.

The two patients who form the basis of this report were first diagnosed almost fortuitously since their deficiency was primarily in retardation of speech and language development. In spite of their being respectively almost four and three years old, they were started on a phenylalanine-low diet and over a period of three years have shown dramatic improvement in speech and language as well as in mentation.

CASE REPORTS

Case 1. A.N. born March 26, 1953. The child was first seen by one of the authors (WMD) on March 17, 1956, at the age of three years. He had been referred by his pediatrician with a possible diagnosis of congenital aphasia. It had been noted that his sibling, aged two, was also showing some retardation in speech development (S.N., case 2).

A.N. was the product of the first pregnancy of a 26-year-old mother. Pregnancy was not remarkable, and no abnormalities were noted at birth or in the neonatal period. The child sat up at the age of six months and walked at 13 months. He began to feed himself at the age of 15 months and was described by the mother as very neat and meticulous. He was toilet trained at the age of 20 months. He was, however, a disciplinary problem, having frequent temper tantrums and crying a great deal. He did not bang his head but was generally hyperactive. He slept well at night. His attention span seemed rather limited. He made friends with strangers and separated easily from his parents.

He was considered completely normal by his parents and pediatrician except for the fact that he did not start saying single words until the age of 30 months. He learned several words, such as *yes, ok, horse, baby, hi* and *no,* but after short use he no longer said them. No sentences or phrases had emerged. He expressed his wants by jabbering, some single words, and gestures. He attended to social noises as well as speech. He followed commands and performed simple errands upon request.

In a complete hearing evaluation, the audiologist was unable to detect any loss. A.N. refused to attempt any item on the Leiter International Performance Scale. On the Stanford-Binet, Form L, he completed two items successfully at the two-year level (identifying objects and block building), refused all items at the 2.5-year level, and strung beads at the three-year level. His drawing was confined to straight-line scribbles and he held the crayon crudely. On the Vineland Social Maturity Scale he received a social age of 2.6 years. The testing indicated that the patient was not grossly retarded, but his test scatter and behavior indicated organicity. He was tentatively diagnosed as an expressive aphasic child and placed in a delayed speech group. Several months later he was referred for a neurological examination which was entirely within normal limits. There seemed to be no evidence of organic brain damage. However, an electroencephalogram was obtained and found to be abnormal (Table 1). The diagnostic impression of congenital aphasia was confirmed.

The diagnosis of phenylketonuria was not established until later. A neighbor told the mother that A.N.'s urine had an unpleasant odor. The mother reported this to her pediatrician who then conducted the Følling test which was found to be positive. The child was admitted to the University of Kansas Medical Center for evaluation on October 29, 1956. All other laboratory examinations were within normal limits.

The child was started on the special phenylalanine-low diet outlined by Armstrong and Tyler (2) in February 1957. To each cup of the casein hydrolysate containing added minerals and vitamins were added six tablespoons of Wesson oil and 1½ cups of sugar. The amounts of celluflour were varied according to the consistency of the child's stools. No other foods were used with the exception of Coca Cola and chewing gum. At the end of two weeks, the urine was found to be negative to the Følling test and the child then received an additional five grams of protein daily. After two weeks, the urine still being negative, the amount of protein was increased to seven grams. The protein amount, consisting of fruits and vegetables, was gradually increased until it reached 15 grams. At that level the urine was found to be positive and the protein was cut to 10 grams daily. The amounts of protein were again slowly increased until November 1957, when the urine remained consistently negative with as much as 20 grams of protein daily. The child was switched to Lofenalac in late April 1958 and has continued on it until the present time. Except for occasional vomiting the child has tolerated the diet extremely well and has shown very satisfactory weight gain.

After he had been on the diet for nine months, A.N. (CA: 4-8) was again seen and the mother reported that he was using a total of 106 words as compared to the 13 words at the beginning of the diet. He had been using phrases consistently for about three months. The mother reported he did not try as hard as his younger

brother to say words and he also did not imitate as well. A formal articulation test was accomplished for the first time. His speech was characterized primarily by omissions and substitutions in the initial and medial positions. He continued to use many gestures and concrete responses to the pictures, *e.g.*, 'bye-bye-zoom/car,' 'sleep/bed,' 'eat/orange,' and when shown a picture of teeth, he gestured the action of brushing them. His expressive language level was estimated at approximately two years. It should be noted that much of his improvement in language development had occurred in the preceding three months.

On the Ammons Picture Vocabulary Test he received a mental age of 5.0 years. It was believed that this finding was probably spuriously high. His social age on the Vineland was 4.3 years, which was almost up to his age except for his language items. He was able to draw a person for the first time and received a credible four-year, three-month mental age. However, from a qualitative viewpoint the drawing was very immature and his perceptions distorted. His performance on the Randall's Island Test was scored at 3.5 years as compared to the previous test score of 2.6 years, which was a gain of almost one year in eight months. The Revised Stanford-Binet, Form L, was administered with the omission of tests which require verbal response. He passed all items at the three-year level, most tests at the four-year level, but failed all at the five-year level. The estimated developmental level was 48-50 months and IQ of 88. On the Seguin Formboard his best of three trials was 27 seconds (six-year level) as compared to 141 seconds (less than three-year level) 12 months before.

After 15 months (CA: 5-2) of diet, the child's motor activities and coordinations, such as dressing himself, coloring, cutting with scissors, and hammering nails, appeared to be on a par with children of his age. On an articulation test he was moderately impaired. His language patterns had improved a great deal since he was last seen. He commonly used three- or four-word phrases and was making complete sentences. This child's language was approximately at a three- to three-and-a-half year level. His voice quality was breathy.

On the Geometric Designs Test he passed the circle and cross (a three-and-a-half year level) but failed the square (a five-year level test). On the Performance Scale of the Weschler Intelligence Scale for Children, he received an IQ of 80. All of the items were below the mean for his age except Picture Arrangements on which he scored above the mean. On the Draw-A-Person he received a mental age of five years, six months. On the Ammons Picture Vocabulary Test he received a mental age of 5.75 years, Six months earlier he achieved a level of 5.0 years on this same test.

After 21 months of diet A.N. (CA: 5-8) was again evaluated. A year earlier his expressive speech was estimated to be at the two-year level. During the ensuing six months he went from three- and four-word phrases to talking in complete sentences, saying from four to seven words. He defined in terms of use and named primary colors. He distinguished left and right in himself and in others. His expressive speech was estimated to be between the four- and five-year level. His receptive level, as measured by the Ammons Picture Vocabulary Test, also showed remarkable changes. A year before his mental age on this test was five years and now he had a mental age of 6.25 years. Even if the measures were spuriously high, they indicated a growth concomitant with his chronological age.

On the Draw-a-Person Test he achieved a mental age of five years, three months. On the Geometric Designs he successfully passed the square which is at the five-year level. On the Vineland Social Maturity Test he achieved a social age of 5.5 years. On the Ammons Picture Vocabulary Test he achieved an age of 6.25 years. The Stanford-Binet, Form L, was repeated and an IQ of 96 was obtained. The mental age was five years, five months, with failures at the 4½-year level and successes up to the seven-year level.

After two years of diet he was seen once more in January 1959 (CA: 5-10). He was in regular kindergarten and except for some apparent difficulties in understanding, especially when placed under pressure, he was performing at the normal level. He received a grade of satisfactory for all areas with the exception of knowing his address and phone number. He listened well and entered freely and willingly into all school activities. He was interested, happy, and well-behaved, and he contributed to class discussions.

His language abilities at this point are best described by indicating what he cannot do at a five-year level. He was unable to count 10 objects and still occasionally

TABLE 2. Summary of development of phenylketonuric child A.N. before and after beginning of diet February 1957.

	April 1956	*Dec. 1956*	*Nov. 1957*	*May 1958*	*Nov. 1958*	*Jan. 1959*	*Dec. 1959*
CA (years-months)	3	3–9	4–8	5–1	5–8	5–10	6–9
Geometric Design	Scribble straight line; 2 yr.			Passed O, +; fail square	Pass square		Pass diamond
Draw-A-Person (years-months)		Could not do	4–3	5–6	5–3	6–9	7–9
Binet*	Completed only 3 items	Estimated 78	Estimated 88		96		96
WISC							
Verbal				None tried		89	85
Performance				80		96	87
Full						91	85
Vineland (years)	2.6	2.7	4.3		5.5		6.0
Ammons (years)		3.7	5.0	5.75	6.25		6.5
Speech and Language							
Receptive	Inconsistent	Improved			5 yr.		6 yr.
Expressive	12–15 mo.	Several new phrases 18–20 mo.	Phrases consistent; 2 yr.	3–3½ yr.	Sentence av. 4–7 words; 4–5 yr.		5–6 yr. Speech distorted
Vocabulary (words)	2; 5 dropped	13	106		550		†
Speech Therapy	Group 2x/wk.	Individual 3x/wk.	None	Individual from age 4–10 to 5–6			None
School		Preschool 3x/wk.			Kinder-garten		First grade

* Until CA 5–8, verbal items were omitted.
† A record was no longer kept of vocabulary growth.

says 'me/I.' His quality of language usage was not as good as most five-year-olds, although he averaged five to seven words per sentence and used *in, an, of, etc.* The mother, who has kept a vocabulary growth log, estimated his conversational vocabulary to include some 550 words, whereas up to 2000 is considered normal for this age.

On the WISC he achieved a Verbal IQ of 89, Performance of 96, and Full Scale IQ of 91. All items except Picture Arrangement had improved over the last testing. Two of the tests, Picture Completion and Object Assembly, were above the mean; Coding was the poorest. On the Draw-A-Person Test he achieved a mental age of six years, nine months. The figure had a great deal of detail with the primary emphasis on the head which was all out of proportion to the rest of the body.

After 34 months of diet, A.N.'s (CA: 6-9) language evaluation revealed that his receptive and expressive levels were probably adequate for his age. However, his speech was very unintelligible and contained many articulation errors. He was capable of making the impaired sounds in isolation. Vocal characteristics included a breathy voice quality, high pitch, fast rate, and unusual inflection patterns. He was attending the first grade in a private

school. The mother reported that he was having difficulty keeping up with the class. In reading he learned the words slowly and forgot them quickly. He could print fairly well.

The Binet, WISC, and Ammons test results indicated a plateauing at the lower end of normality. The difference between the Binet (IQ 96) and the WISC Full Scale (IQ 85) was probably a chance variation. The same rate of improvement noted in the first two years did not appear to continue during the third year of dieting. See Table 2 for summary of evaluations.

In the latter months of the third year the mother had been permissive with the diet. She had been getting as many as two 'positives' a week on the Phenistix test. Control of excessive protein intake on the basis of urine tests was probably not adequate, but because of technical difficulties no other way was available. The mother cannot be blamed for giving the children extra food because they were continually hungry. The Lofenalac diet does not fill them up. In addition, the social and emotional problems concerning dietary control has increased since the children have been in school.

Case 2. S.N. born April 6, 1954. This child was first seen when he was admitted to the University of Kansas Medical Center on October 29, 1956, after the diagnosis of phenylketonuria had been made in his older brother. This child was the product of the second pregnancy of a 27-year-old mother. Pregnancy was full term and uncomplicated. Birth and neonatal periods were not remarkable. This child sat up at six months and walked at 13 months. The child was moody, fretful, and difficult to handle. At the time of the examination, age two years, six months, he had no speech and was not toilet trained. The child had no epileptiform manifestations. He has light brown hair and brown eyes. EEG at this time (as well as subsequent EEG's) are reported in Table 1.

Before going on the diet S.N. (CA: 2-10) had no expressive speech. There were no evidences of a hearing problem. On the Ammons Picture Vocabulary Test he received a score of 2.5 years. He failed the Seguin Formboard (less than three-year level), scored less than the two-year level on the Geometric Designs, and achieved a little more than the two-year level on the Randall's Island Test.

After nine months of diet (CA: 3-6) his mother reported that he would try to say almost anything they asked him and that he now had a vocabulary of 120 words. He used phrases and his expressive speech was estimated at the two-year level. No spontaneous speech was heard, his only response being a deep, gruff, explosive laugh. He was quite hyperactive and he had a very short attention span.

He was unable to produce anything but a scribble on the Draw-A-Person Test, and the same for the Geometric Designs of circle and cross. However, he was noted to produce a circle spontaneously later on. His social age on the Vineland was 3.0 years. The Ammons Picture Vocabulary score was 4.75 years, but it was believed spuriously high. On the Randall's Island Performance Test he scored a mental age of 2.8 years. The Stanford-Binet, Form L, was administered, omitting tests requiring a verbal response. S.N. functioned at about the 35-37 month developmental level (approximately 85 IQ). He had a very irritable attention span which flitted from object to object unless the situation was greatly restricted for him. On the Seguin his best time in three trials was 94 seconds, which is at the four-year level.

After 21 months of diet S.N. (CA: 4-7) was examined again. He was not attending nursery school. The most outstanding change was a definite inhibition of his former hyperactive response, although he still was very immature. An articulation test was obtained for the first time and was found to be within normal limits. A hearing test was attempted, and although he allowed the headphones to be placed on his ears, he could not be conditioned. The mother reported that he repeated words well but that his language was less coherent than his older brother's (Case 1). His language ability was still below what one would expect at this age. The mother believed that he had a good imagination and creative ability.

His eye-hand coordination was poor in that he was only able to copy a circle but not the cross. He achieved an age of 3.9 years on the Vineland which meant an improvement of about one year in the previous 12 months. On the Ammons he achieved a mental age of 4.75 years. This was the same as the score that he received one year before. However, it was noted then that the score was spuriously high. The later result was probably valid for

TABLE 3. Summary of development of phenylketonuric child S. N. Corrective diet was started February 1957.

	December 1956	*November 1957*	*May 1958*	*November 1958*	*December 1959*
CA (years-months)	2–8	3–7	4–1	4–7	5–8
Geometric Design	Fail 2 yr.	Fail 2 yr.	3 yr.	3 yr.; fail cross	Pass square
Seguin Forms	Fail 3 yr.	4 yr.			
Draw-A-Person		Fail	Fail	Fail	5–0
Binet*	Borderline	Estimated 85		90	101
Ammons (years)	2.5	4.75	4.25	4.75	6.0
WISC					
Verbal					76
Performance					76
Full					74
Randall's Island (years)	2.4	2.8			
Vineland (years)		3.0		3.9	5.0
Speech and Language					
Receptive	2 yr.			4 yr.	5 yr.
Expressive	1 yr.	Phrases 2-year level		5–7 word sentences; articulation normal 4 yr.	6–8 word sentences
Vocabulary (words)	0	120		250	†
Speech Therapy	None	None	None	None	None
School	Nursery school Fall 1957		Spring 1958		Kindergarten

* Until CA 4–7, verbal items were omitted.
† A record was no longer kept of vocabulary growth.

this test. On the Stanford-Binet, Form L, his mental age measured four years, two months, which gave an approximate IQ of 90.

After S.N.'s diet had been controlled for two years (CA: 4-9), his mother estimated that he had about 250 words in his vocabulary. His average sentence length was 4-6 words, but he still referred to himself as 'me.' He was able to count to four or more by rote and understood the concepts of 'one' and 'many.' He also knew what to do when 'tired' or 'thirsty.' In quality his responses were not as good as A.N.'s and were still sometimes inconsistent with the situation. His voice quality was breathy and monotonous. He was quiet and well-behaved. The mother believed that his progress was even more dramatic than that of his older brother. S.N. has not adjusted as well to his diet and shows a very strong craving for meat which he will try to eat raw if given the opportunity. Both boys are now getting about 25 grams of protein daily in addition to the Lofenalac.

After 34 months of diet, S.N. (CA: 5-8) was given another speech and language evaluation. Outstanding aspects of his speech included good articulation of isolated words, poor conversational intelligibility, and deviant voice characteristics. The voice was unusual because of breathy quality, high pitch, fast rate, and unusual patterns of inflection and stress. His language usage continued to improve in that he was using longer sentences and better syntax. He was judged to relate more readily on an interpersonal basis.

Since starting kindergarten, he has learned to name colors, to count to 14, and to follow group instructions in class.

However, he has not learned to print his name. He was still distractible and some drooling was present. The psychological tests showed a great improvement in his eye-hand coordination over the previous year. The disparity found between the Binet (IQ 101) and the WISC Full Scale (IQ 74) is difficult to explain. These results indicate the hazards in testing atypical children. Although S.N. functioned in many ways within the average range of intelligence, he was not a 'normal child.' See Table 3 for summary of evaluations.

Discussion

In evaluating the progress of children with phenylketonuria, one must take into account the fact that a number of such patients have been reported as having normal or only mildly subnormal intelligence (*6*, 7, *8*, *11*, *14*, *15*, *16*). However, Jervis (*14*) pointed out that only six per cent of 330 persons with phenylketonuria have IQ's above 50 while Paine (*17*), reviewing the developmental history of 106 patients, found only 1.9 per cent to have IQ's over 50. The present authors are well aware of the hazards in testing atypical children, particularly those below the age of four. Many children who are not phenylketonurics have improved in mental age between ages two and four. However, the response of these two phenylketonuric children to treatment was unusual considering the age at which they were started on the diet. The improvement noted in mentation following a dietary regimen started after two years of age has generally been disappointing. However, Horner, *et al.* (*10*) reported on three children ages four-and-a-half, four, and three-and-a-half who had respective IQ's of 35, 37 and 42. Following 22, 20 and 11 months of diet their respective IQ's were 69, 70 and 40. Two of them were greatly improved and the other had not changed.

There can be no question about the fact that in terms of early development, the two patients were not severely retarded. Except for speech they had reached the usual development landmarks at the proper age and thus demonstrated that their cerebral deficit was originally much less marked than is usual in children with phenylketonuria. This lesser degree of deficit may have been an important factor in their improvement; nevertheless, the increase in functional mentation seems to be significant. It is not suggested that the innate potential was increased but, rather, that the pernicious effect of the disease was removed, enabling improved cerebral function. The original test scatter, from defective function to near normal, would indicate the patchiness of the original deficit. Tests which require eye-hand coordination and/or visual perceptual ability were the most impaired next to the language deficits.

One of the main reasons for presenting these two cases in such detail is the fact that the primary presenting symptom was the speech and language impairment. A.N. was diagnosed by two speech pathologists, a psychologist, an audiologist, a pediatrician, and a neurologist as being congenitally aphasic. His younger brother was also believed to be an aphasic. Since many speech pathologists see children who are delayed in speech and language, it would be well to be aware of phenylketonuria as a disease entity.

The fact that speech was so severely involved in these two cases is not unusual. Paine (*17*) pointed out that in the phenylketonuric child the mean age for sitting is 12-15 months, for walking 2.5

years, but for talking as late as three to four years. He further stated that talking is most universally delayed. Two children described by Clader (*6*) had not developed any meaningful language at age four, but after one year of diet marked improvement was noted in language usage. One child (*15*) diagnosed as phenylketonuric at age six had been referred for evaluation because she was slow in her studies and had mirror writing. Her case history revealed that she started to talk at two and began using sentences with increasing clarity but had been ridiculed at school for difficulty in pronouncing her consonants. Cowie (*8*) reported an atypical case of phenylketonuria who had been institutionalized as an imbecile. He sat at nine months, walked at two years, and talked at three years (only a few words). Testing at chronological age seven years, eight months, on four performance tests revealed IQ's from 90-97. His low Binet score of 76 was attributed to institutionalization. As a rule, the natural history of the disease is lack of development, actual deterioration probably not occurring (*14*). However, in some instances, previously acquired skills, such as speech, have disappeared as the child grew older.

It is of interest to note that A.N., from age three to age four (prior to diet), had a great deal of speech and language therapy as well as stimulating socialization in nursery school experiences with negligible results. Whether or not he would have made the same gains that were eventually obtained in speech and language without the diet is an unanswerable question. S.N. had no speech and language therapy and only six months of nursery school prior to diet. It appears unlikely that the speech would have improved to such a degree if the disease had remained untreated.

The remarkable initial delay in showing improvement in speech and language after the initiation of dietary treatment in the two patients is of interest. In spite of some initial general improvement in behavior, speech did not begin to improve until six months later. It is worthwhile noting that in spite of the urine test being negative, the children's serum phenylalanine level was still elevated three months after starting the diet, and it was probable that the beginning of improvement coincided with return of the serum phenylalanine to normal levels. Hsia, *et al.* (*12*) found that a decrease in serum phenylalanine levels occurred within three to six weeks in most patients but that in others five months or more passed before satisfactory chemical control was achieved. We have been unable to follow serum levels of phenylalanine in these two children due to a number of technical difficulties. The parents of these two children are of above average intelligence and have managed the diet with little supervision, titrating the amounts of extra protein against the results of the grossly quantitative Fɸlling test performed with Phenistix.[1] This procedure has seemed satisfactory as evidenced by the fact that a check of the serum phenylalanine levels 20 months after a dietary regimen was found to be within normal range.

At the present time, no one can say how long this dietary regimen must be continued. It was suggested (*16*, *21*)

[1]Paper strips which when moistened with urine of patients with phenylketonuria give a characteristic color.

that the low phenylalanine diet possibly need not be maintained after adequate development of the central nervous system is complete. A regular diet may then result in the occurrence of biochemical changes without the appearance of 'delayed' mental retardation. The question that remains to be answered is when does the central nervous system become fully developed in terms of the specific metabolic abnormality causing the clinical syndrome of phenylketonuria. The experience of Coates, Norman and Woolf (7) is particularly pertinent. After placing a seven-year-old child with an IQ of 103 on a phenylalanine diet for three months, it was discontinued and a drop of 18 IQ points was found two years later. This would then extend the age at which the possible effects of phenylalanine or its metabolites might have upon the developing central nervous system and suggests that the diet may have to be continued beyond puberty.

Summary

Two sibling cases of congenital aphasia are reported who were later diagnosed as having phenylketonuria. During three years of control on a phenylalanine-low diet, there was noted marked improvement in language as well as in functional mentation. Of particular interest was the fact that the diet was not initiated until the subjects were four and three years of age respectively. It is suggested that speech pathologists be aware of phenylketonuria as a cause of delayed language development in children who otherwise may appear near normal.

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Radiography in Speech Pathology

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Much of the recent research on the anatomy and physiology of the structures used in speech has depended upon radiography as a fundamental method of investigation (*10, 16, 19, 25, 26*). The inaccessibility of the oral cavity and pharynx during speech makes radiography essential to this work. As a result, speech pathologists are increasingly recognizing the value of x-ray in the evaluation and study of the speech mechanism.

The purpose of this paper is to consider the contribution of the radiologist and the radiographic facility to speech pathology and to describe the relationships between these fields. A more comprehensive discussion of the radiographic equipment and techniques employed to this purpose may be found elsewhere (*23*).

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Radiologists

Liaison between the speech pathologist and radiologist requires mutual understanding. Because of the lack of clinical contact between members of these two professions, the speech pathologist may not be aware that radiologists are required to have an unusually broad and diversified training which includes background in the basic and clinical sciences of medicine and special knowledge of physics and electronics. This background should be exploited fully in clinical and research application of radiology to speech pathology.

The radiologist is qualified to recommend radiographic equipment and materials for utilization in the study of speech-related problems. He is able to render opinions regarding the feasibility of certain prospective applications and to recommend radiographic methods of approach. He understands the limitation of radiology and is able to avoid fruitless efforts. Most importantly, he must have final authority in matters of radiologic safety and protection and

establish exposure limits for each individual and for each radiographic procedure.

Speech Pathologist

While the radiologist interprets the x-rays for indications of medical problems, the speech pathologist requires use of the films and facilities for their analysis in order to interpret them for speech pertinent data. Because the radiograph is a summation of shadows of three-dimensional structures superimposed upon a flat negative of a limited field, anyone who utilizes x-ray must know the anatomy of the structures he is studying. Also, knowledge of radiographic anatomy is essential to the speech pathologist who is to plan clinical evaluations and research studies utilizing x-rays. At present such specialized course work is not included in the standard speech pathology curriculum. This background may be obtained by apprenticeship-type of experience in a medical setting and by reference to standard radiographic texts such as Pendergrass, Schaeffer and Hodes (*18*).

Often the speech pathologist assists in the actual taking of the radiographs as he is best qualified to direct the client in phonation. He may also position the subject since cervical posture influences the relative spatial relation of many speech structures (*21*). When still x-rays are taken of speech and of other poses for comparison, the common x-ray technical routine of having the patient take a deep breath and hold it should be avoided.

Equipment

It is essential that the speech pathologist have a general knowledge of radiographic equipment and techniques. A brief description is given of the principal items of equipment and of their availability, utilization and limitations.

Much information about the speech mechanism can be obtained from still radiographs taken with standard equipment. Such equipment is found in radiologic departments in most hospitals, many large clinics, and some private offices. This equipment should be of the type which permits short exposure times in order to stop motion. However, the demonstration and analysis of rapid motion, which is characteristic of speech, requires the use of special radiographic recording equipment. Two basic types of equipment are used for the recording of progressive phenomena —a rapid cassette or film changer and a motion picture of an intensified fluoroscopic image. With each of these it is possible to visualize some transitional phases leading into static speech poses, as well as the apparent climax of the activity. Rapid motion is thus recorded as a sequence of exposures at brief intervals with good rendition of structural detail. Many more exposures per second are obtained with the motion picture equipment than with the rapid cassette changer.

Rapid film changers providing simultaneous exposure in two planes are available in some cardiovascular laboratories or neuro-surgical units. Newer mono- and biplane changers in which 70-mm. roll films are exposed at six to eight frames per second bridge the gap between the still radiographic and the cinefluorographic methods.

A serious limitation in the application of rapid film changers is that the num-

ber of exposures must be restricted because of the high rate of patient exposure to radiation. Since an examination may last only a few seconds, complex motions or series of related motions cannot be encompassed within the time that is available. The observations afforded by this method are infrequent compared with the rate of motion in some speech performances. Brief speech movements, therefore, may occur in the time interval between each exposure. This method has the advantage, however, of having a sufficiently large field to record the structures of the entire head and neck.

The major radiologic advance in motion observation has been in the development of the image amplifier and its associated cine equipment. Motion picture photography of the unamplified fluoroscopic image has been used for many years; but the equipment has been elaborate and expensive, and the radiation dosage to the patient has been excessive. The amplifiers that are now available permit a more complete recording of normal and abnormal speech patterns than was previously possible.

Continuing refinement of existing cine equipment and release of new models make specifications impractical. A combination particularly suited to the study of speech is the image amplifier and closed circuit television since this permits precise coordination of sound and motion. Recording may be by a sound camera with 35-mm. optical sound film, which is superior in many applications to the more commonly used 16-mm. camera with standard film. Commercial models of image amplifiers may be modified to the television camera; this adaptation makes possible the photography and sound recording at a remote location. Currently available image amplifiers vary in the diameter of field they can amplify. Some radiologists feel the distinction of detail is lessened when a field size greater than five inches is used.

All modern cinefluorographic units provide a range of film speeds, often from 15 to 60 frames per second. Suitable 16-mm. and 35-mm. film emulsions of extremely high speed and contrast are available. Many of these may be processed in standard x-ray solutions with no loss of quality; however, the resulting film requires constant care in handling and projection. Even with special solutions and with good projection equipment, the negative film may become damaged after a limited number of projections. Especially valuable strips of film, therefore, should be duplicated on the more durable positive film, at which time it may be desired to reverse the image.

A radiographic unit of considerable value in some studies is the laminagraph, a radiographic device that permits demonstration of a section through a body region by deliberately blurring the images of structures in adjacent parallel planes. Thus, only those structures within the selected plane are sharply rendered. Laminagraphy is used most advantageously when skeletal structures are not clearly visualized with standard techniques or when the soft tissue structures are obscured by skeletal landmarks. For example, in anteroposterior projection, the vertebral background makes standard observation of the larynx inadequate for discrete visualization of the vocal folds, but the laminagraph will show these structures in good detail. With a multilayer laminagraph cassette or film-holder, it

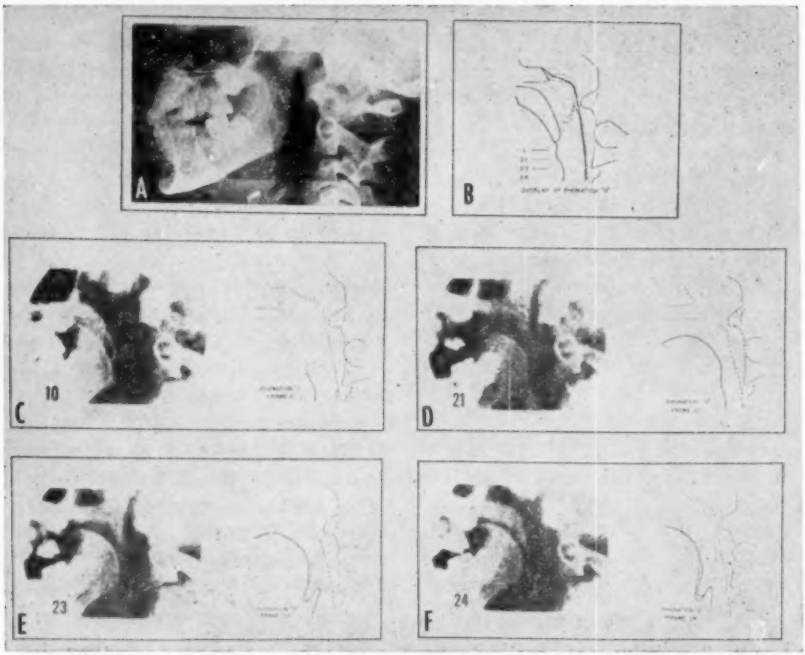

FIGURE 1. Use of overlays. *A* is the reference still radiograph in identical lateral position, with the field of view of the cinefluorographic strip indicated in the darker central area. *B* is a composite overlay of phonation 'o.' *C*, *D*, *E*, and *F* are individual frame overlays and reproductions of cinefluorographic frames from which the composite was constructed. Note the use of bony landmarks as reference points.

is possible to record simultaneously a number of adjacent planes or body sections with a single exposure.

The standard radiographic head unit is also useful for still radiographs, as is the more complex orthodontic cephalostat. These are not essential, however, and simpler equipment will suffice for most purposes.[1]

[1]A radiographic study unit that is suitable for the evaluation of speech problems costs in excess of $30,000 at the present time. Such a unit includes a standard roentgenographic machine, a laminagraph attachment, and a cinefluorographic device with an image amplifier. Routine maintenance and repairs require an annual outlay of at least $3000. Expendable supplies and equipment cost an equal amount.

Occasionally during the course of an investigation the necessity for special items arises. These items are peculiar to the investigation concerned and include such items as chairs with a headrest adapted to fit in the limited space between the fluoroscopic tower and the radiographic table, couches of the same narrow width for supine level views, and immobilization devices for infants and small children.

PROTECTION

Clinical or research investigations which involve x-ray require careful

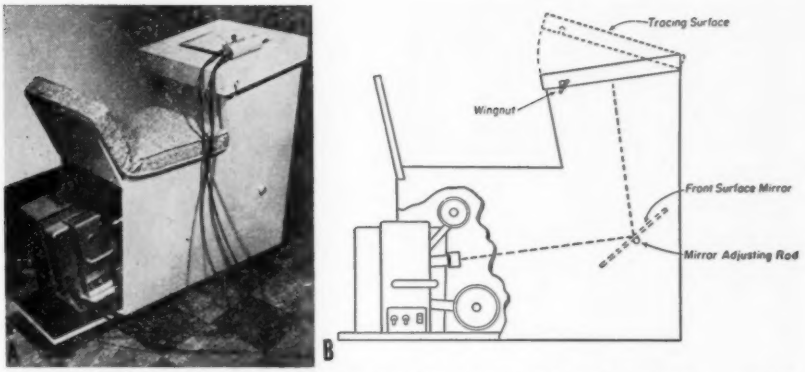

FIGURE 2. Tracing cabinet. *A* is a photograph of the cabinet; *B* is a schematic diagram of its inner construction. Incorporation of the chair and backrest into the cabinet structure permits long periods of work without fatigue. The device to the right of the tracing surface is the remote control. The tracing surface is clear glass, the tracing paper itself being used to form the image.

consideration of the problem of patient protection. Radiographic study of the speech-disabled subject for the purpose of research or teaching is justified only when all safety precautions are taken and when the film obtained is adequately evaluated. Such studies should be planned so that they may benefit the patient. Information gained from research employing radiographic methods should be disseminated in scientific literature and the films made available for exchange among investigators in the field.

External lead shields and barriers should be used both for subjects and operating personnel. Both should wear lead aprons of adequate design and thickness. The gonadal areas in particular should be shielded during all examinations. Longitudinal individual radiation exposure records should be maintained on all subjects, both by the radiologist and by the speech pathologist to permit double checking of records. Failure to be concerned with the potential hazards of x-ray or to take suitable precautionary measures invites justifiable criticism. Periodic review of the radiographic routine may disclose duplication of studies, some of which may be eliminated without loss of information. Total exposure during a typical examination of the speech mechanism can be less than five roentgens measured in air at the table top with a 10x10 cm. field. In contrast, the exposure received during a routine fluoroscopic examination of the upper and lower gastrointestinal tract may be three-to-six times greater.

ANALYSIS OF FILMS

In clinical research employing radiography, it is the responsibility of the speech pathologist to examine the film for speech-pertinent data. Quantitative criteria should be employed in these evaluations whenever possible. Methods of radiographic analysis for measurement of speech-related structures have been described elsewhere (*6*, *7*).

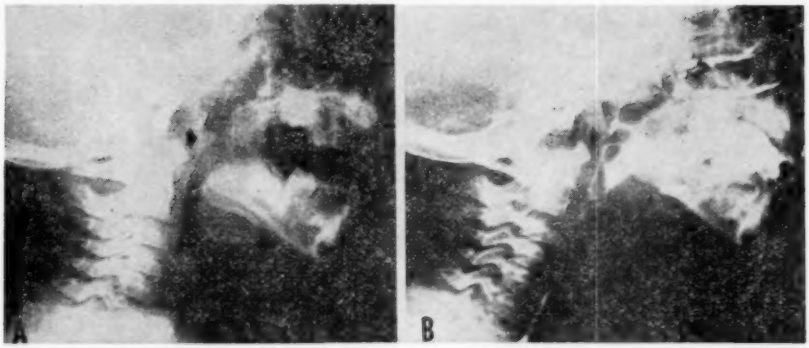

FIGURE 3. Comparison of ridge formed on the posterior pharyngeal wall during phonation (*A*) and during swallowing (*B*). The ridge is more prominent during the swallow and serves effectively in this activity to achieve palatopharyngeal closure. Although the ridge is also present during phonation, it is insufficient to prevent nasal voice quality.

Still radiographs, laminagraphs and cinefluorographic strips supplement one another in the analysis of a given activity (Figure 1). A still radiographic plate of the subject in the same position as each cinefluorographic sequence helps to orient the observer to the region studied and facilitates interpretation. Still radiographs, including single series of films, taken with a rapid film changer and laminagrams, are examined on standard radiographic illuminators. Measurements are made with calipers, rulers, protractors and map measurers. Where one pose is to be compared with another, an overlay tracing of the other may be aligned with the second or, if a series of films are to be compared, a composite overlay tracing may be used. The writers use cranial orientation points to align the tracings.

Some structural anomalies may be identified in single films without resorting to measurements. Analysis of cinefluorographic film of articulate speech may require comparison of frame-by-frame tracings. Figure 2 illustrates a tracing cabinet which is inexpensive to construct but can save tracing time when used with a suitable projector. The projector should permit sustained single frame projection without damage to the film, variable speed projection forward and backward, remote control, and frame counting. An electric fan may be required to cool the projector when it is being used prolongedly. With this cabinet-projector combination, the tracings made by single frame projection may be validated by motion projection and, additionally, some subtle soft tissue details are clarified as they are viewed in motion. The accuracy of such observations should be confirmed by other experienced persons. Since the variable speed projectors may not reproduce sound, a second sound projector may be required.

CONTRIBUTING SPECIALISTS

The speech pathologist who plans to utilize radiology will need the cooperation of a physician inasmuch as most radiologists take referrals only from

medical doctors. The referring physician is legally responsible for the physical welfare of the patient and determines whether planned studies are appropriate and whether the patient is in suitable condition for the examination.

Various medical and dental specialists may contribute to use of radiologic examinations of the speech mechanism depending upon the type of problem under study. Films taken for study of one aspect of a patient's problem may also be utilized for study of the speech mechanism (Figure 3); *e.g.*, cephalometric headplates taken for the orthodontist and cinefluorographic studies of the pharynx taken for the otolaryngologist may also be useful to the speech pathologist. In order to utilize radiology in speech to the advantage of the speech-disabled person, suitable interprofessional relationships must be established where such work is to be done.

Speech Problems

Radiography has recently received renewed attention from persons working in the field of speech pathology. Many research studies reported in the speech literature have utilized x-ray in the experimental procedure (*10, 20, 22*). Radiology is being used to evaluate closure of the palatopharyngeal isthmus during phonation by persons with nasal voice quality (*4, 5, 8, 11, 12*). In speech pathology, as in medicine, radiologic examination must be considered as supplementary to expert physical examination. Valuable information can be gained from the use of still and motion photography, subjective and spectrographic analysis of sound, subjective evaluation of muscle strength and of the rate of voluntary movements, and from other methods of examination. Generally x-ray should be reserved for those observations that cannot be made adequately in other ways.

It has been the experience of those who have used radiography that it is required with diminishing frequency in patients having similar patterns of disability. However, many current and potential applications of radiology in speech do exist. Among them are the following:

1. *Speech Performance in Normal Subjects.* Many of the limits of normality of the structures of the speech mechanism and their function have not as yet been defined. This is particularly true in the infant and young child. Since these structures can be examined directly during only a limited number of clinical performances, progress in this phase of speech pathology is largely dependent upon radiologic observation. Although radiologically derived data are available on growth of the structures of the oropharyngeal region and on spatial relationships of these structures during phonation of certain isolated sounds, little progress has been made in relating these findings to speech articulation.

2. *Speech Disturbance Resulting from Unusual Variation in Normal Structures.* Variation among the organs of the speech mechanism may account for certain speech problems. As an example, an individual may have a pharynx which has measurements within the upper limits of normal and a palate which has size and activity within the lower limits of normal. The combina-

tion of these extremes may then result in hypernasal voice (*15*). Conversely, a relatively small pharynx in conjunction with a large soft palate could, with minimal development of adenoid tissue, result in a denasal voice. Through cephalometric evaluation these discrepancies can be detected.

3. *Anomalies in Form.* Disturbances in voice and articulation are directly related to form and function of the speech structures. The tongue, soft palate and larynx, which are most difficult to evaluate by direct inspection during speech, can be visualized radiographically (*13, 24,* 27). Skeletal aberrations in the oral, pharyngeal and laryngeal regions can affect speech performance, also. Many of these disturbances have been identified and measured by cephalometric techniques of radiographic analysis.

4. *Compensations for Organic Involvement.* Seemingly identical organic involvement can vary in the effect upon speech. Normal or near-normal articulation may be found in an individual with aglossia (*14*), or normal voice may be found in an individual with a complete cleft of the palate (*17*). Radiographic observation of such persons may help to identify the methods of compensation which are employed. This information may then be applied to improve therapeutic approaches to speech disorders of other individuals who have similar organic involvement.

5. *Differentiation of Functional and Organic Bases of Speech Disability.* Speech may be abnormal because of faulty learning or emotional disturbance. Radiographic visualization may be required to evaluate such disturbances and to demonstrate normal basic structure. Comparison of voluntary and reflex activities may help to differentiate purely functional disturbances. Such use of x-ray would be supplemented by other methods of evaluation.

6. *Muscular Insufficiency.* The two principal effects of primary muscular disorders are weakness and diminution of mass. Muscular insufficiency such as that in dystrophy may result in general disturbances of speech or in disability of particular structures, such as the tongue, soft palate or larynx. Radiographic comparisons among different maneuvers before and after exertion of the speech-involved structures can demonstrate the fatigue resulting from certain types of myopathy, as myasthenia gravis. Radiographic observations of the subject in different body positions may be used also to evaluate weakness of suspensory musculature of the mouth and pharynx.

7. *Impairment in Neurologic Function.* Patterns of speech disability in neurologically impaired individuals are demonstrable by radiographic methods. Through radiographic comparison between speech and various other activities, such as mastication and deglutition, more subtle neurological disturbances may also be manifested (*3*). Identification and extent of involvement in disease such as poliomyelitis have relied extensively on radiographic criteria (*1, 2*).

8. *Effects of Trauma or Destructive Disease.* Radiography aids in determining the extent of disability resulting from destructive disease or injury such as malignancy, chemical and thermal injury or penetrating wounds. The possible deleterious effects upon speech from removal of tonsils and adenoids

may also require radiographic methods of pre- and postoperative analysis.

9. *Evaluation of Medical and Dental Therapeutic Procedures.* Radiography has proven to be of help in planning surgical and prosthetic therapy in treatment of speech-disabled individuals. Comparison of the pre- and posttherapy films permits documentation of results. Radiographic visualization is particularly advantageous in attaining proper placement of a prosthetic device, such as a bulb obturator (*9*).

10. *Evaluation of Speech Rehabilitation Procedures.* The improvements in speech resulting from standard routines of speech rehabilitation require additional physiological description. Radiographic methods of observation can help in evaluation of remedial progress as well as in identifying remedial procedures in need of modification. Longitudinal studies which would be most advantageous for this type of problem, however, may have to be severely limited to avoid excessive patient exposure to radiation.

The potential contribution of radiology to the field of speech pathology is far from being realized at the present time. With day-to-day improvement in radiographic equipment and procedures and in methods for obtaining further information from the films, radiography can become increasingly useful to the person engaged in either the clinical or research aspects of speech pathology.

Summary

In this paper the training of the radiologist, the potential contribution of the radiologist and radiologic facility to speech pathology, and the professional relationship between the two fields are discussed. A brief description is given of the principal items of radiographic equipment and of their availability, utilization and limitations. Some current and potential applications of radiology in speech are listed and described.

Acknowledgments

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Historical Aspects of Manual Communication

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- *Herbert J. Oyer*
- *Susan M. Wolfe*
- *Edward A. Abernathy*
- *Ben M. Schowe, Jr.*

For centuries there has been disagreement among those interested in the acoustically handicapped concerning the way in which this group of handicapped should be taught to communicate. Some have advocated the use of the manual method whereas others have advocated the teaching of speech and lipreading. Still others maintain each method has certain advantages and have included both in their instruction. It is not the purpose of this paper to compare the oral and manual approaches, but rather to achieve a better understanding and appreciation of the manual method.

Hand signals have been used as a medium of communication for some time, not only by the Armed Services and by aeronautical groups, but also by railroad and construction workers, underwater divers, American Indians, and the deaf. Signals are observed daily in athletics, principally football and baseball, and in traffic and driving. However, little or no uniformity exists among these signals because of technicalities and individual development brought about by specific needs. The majority of the signals have arisen from operational use rather than from any systematic approach.

The need for communication under conditions when voice procedures are

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The study was carried out under Air Force Contract No. 19(604)-1577, monitored by Operational Applications Laboratory, Air Research Development Command, Bolling Air Force Base, Washington 25, D.C.

impossible or unfeasible has made the study of hand signals important. The discrepancies and inexactness existing in the hand signals presently in use in aeronautics especially have produced problems which demand work on standardization and clarification of hand signals. It was conjectured that the one-handed finger spelling of the deaf might serve as an already standardized set of hand signals to be tested for intelligibility as well as a possible tool to be used in qualifying the hand signals selected for use in aviation or in any other field. In a sense, finger spelling might occupy the same relationship to visual communication that the word spelling alphabet does to voice communication.

The finger spelling alphabet consisting of 26 hand signals which are differentiated by fine or small hand and finger movements is presented in Figure 1. It is used by the deaf as a means of more formalized communication among themselves.

This review of pertinent historical literature related to finger spelling was the initial stage in an experimental study of the intelligibility of finger spelling. Insofar as it can be determined, such an experimental study would represent the first attempt to scientifically evaluate the efficiency of such a form of communication. A subsequent article will present the results of such experimentation.

Origin

Finger spelling, or dactylology, is of uncertain but ancient origin. Best (*2*) states that the Egyptians, Hebrews, Greeks, Romans, and others made use of a finger notation or symbolization.

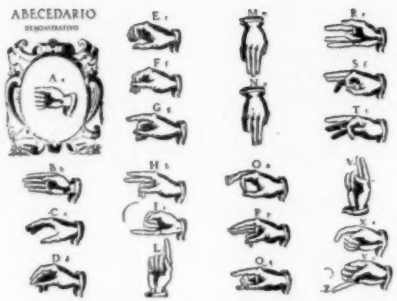

Figure 1. Old Spanish finger spelling alphabet.

Persons in enforced silence, notably monks of the Middle Ages, often resorted to this practice. Late in the seventh century the Venerable Bede wrote about manual alphabets, referring to three different forms which were in existence before his time. Latin Bibles of the tenth century contained pictures of dactylology. Systems somewhat on the order of those now in use appeared in the sixteenth century. In 1546 there appeared a brief work on the subject, with examples, called *Chiromantia*. Most of these writings came from Italy.

In a voluminous work on the dactylology of the ancients, Barrois (*1*) formulated a pre-Hellenic one-hand alphabet based on his highly fanciful interpretation of the position of the fingers in ancient statues, paintings and similar works. Much of his interpretation is based on imaginary Greek equivalents. He regards dactylology as the basis of Chinese writing, and he likens the characters in an ancient Phoenician papyrus to formations by the fingers. These absurdities are compounded with interpretations in Greek of Assyrian, Egyptian, and ancient Mexican figures, and even an illustration in a French

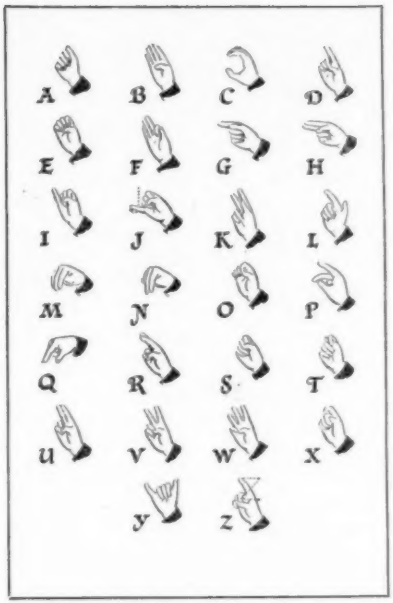

FIGURE 2. Present day one-hand finger spelling alphabet of the deaf.

publication of 1686. While Barrois' imaginative alphabet is not to be considered authentic, his work does raise a question as to the meanings intended by stylized but unusual finger formations found in ancient statues, vase paintings and bas-reliefs.

Farrar (*6*) observes that the earliest finger alphabets extant appear to have been founded on manual signs for numbers, described by Bede in his *De Temporum Ratione*. There is evidence that these manual alphabets were in common use in the Middle Ages for purposes of secret or silent discourse.

Some forms of manual communication dating back more than 1000 years came down through the Middle Ages, quite likely through religious orders under vows of silence and by those who desired secret or silent communication. It does not appear that any manual alphabet was used in instructing the deaf during that period. Farrar (*6*) notes that Jerome Cardan (1501-1576), an Italian mathematician and physician, urged the importance of teaching the deaf to read and write, explaining ideas by the use of signs. Farrar also states that there is no evidence of the use of a manual alphabet by the first regular instructor of the deaf, Pedro Ponce de Leon (1520?-1584), though apparently he did use signs. Pedro Ponce de Leon joined the Benedictines and spent most of his life in their monastery at Ona. Hodgson (7) comments that 'possibly the monk remote in his monastery at Ona never heard of this technique (of a manual alphabet) but was on the other hand used to conventionalized signs for certain purposes within the community.'

ONE-HAND ALPHABET

In 1597 Rossellio (*11*) showed one-hand forms for the alphabet. For a majority of the letters he gave three forms presumably for three different alphabets; but for *S*, *T* and *V* he gave two forms, and for *X* only one. No forms were given for *J*, *K*, *R*, *U*, *W*, *Y* or Z. He also pictured a common device for manually indicating letters and figures by pointing to various parts of the body. However, pointing to parts of the body for letters was grotesque and awkward and gradually gave way to more practical manual alphabets. Some of Rossellio's rather crudely drawn one-hand forms show similarity with present-day forms for *B*, *F*, *I*, *L*, *M*, *O*, *P*, *Q* and *X*.

The greatest contribution to the one-

hand alphabet is perhaps that of Juan Pablo Bonet (*3*), who died in 1629. His *Reduccion de las Letras y arte para Ensenar a Ablar los Mudos* (simplification of the letters and the art of teaching deaf-mutes to speak) is the earliest extant work on the education of the deaf. In Book KK, he gives the 'Abecedario Demonstrativo,' beautifully engraved reproductions of a one-hand alphabet (Figure 1). With minor modifications, this Spanish alphabet is quite similar to the one widely used today in the United States and continental Europe (Figure 2). By comparison, many of the letters are identical, a few similar, and only *D* and *R* show marked differences. There is no *J*, as *I* was used instead, *V* and *U* are the same, and there is no *K* or *W* in Spanish. Farrar notes that little is known of Bonet and adds, 'He was a man of the world rather than a cloistered teacher like Ponce de Leon, and as a matter of fact, there is scarcely any evidence that teaching the deaf was at any time his vocation' (*6*). He wrote his book out of gratitude to his master, whose brother lost his hearing and was tutored by Ramirez de Carrion. Bonet does not mention Ramirez de Carrion. He may not have had any share in Luis de Velasco's education, but in his book he has described the method pursued.

Commenting on the above, Peet (*9*) said that Bonet did not claim the merit of originating the widely used manual alphabet . . . and there is some doubt whether the alphabet given by himself, which differs essentially from those known to have been used by the ancients, was his own invention, or was adopted by him, ready-made.

Bonet (*3*) cited an older method of using parts of the body for letters, saying '. . . in antiquity it was considered the right thing to do to know how to use the demonstrations of the hands and other parts of the body in order to signify letters and figures.' Juan Bautista Porta (*10*) also writes that parts of the body were designated by pointing or gesturing to signify the letters: *e.g.*, *A*, Auris-las orejas (ears); *B*, Barba-la barba (chin); *C*, Caput-la cabeca (head); *D*, Dentes-los dientes (teeth), *etc.* Bonet notes that *K*, *X*, *Y* and Z were not used in the Latin language (*3*).

The Spanish alphabet was introduced into France by Jacob Rodriques Pereire (1715-1780), the first important teacher of the deaf in that country. Pereire had a deaf sister to whom he gave instruction. Later he taught other deaf pupils. In 1749 he brought one of his pupils before the French Academy of Sciences in Paris. A commission appointed by the Academy to report on the value of Pereire's methods commented on the use of the manual alphabet. Subsequently, Pereire achieved even wider recognition. He kept his methods secret, but through his most outstanding pupil, Saboureaux de Fontenay, who also became a teacher of the deaf, we can gain some knowledge of Pereire's methods. The most distinctive feature was the use of Spanish manual alphabet, which he enlarged and augmented to conform to French pronunciation and orthography (*6*).

Up to this time education of the deaf had been for the privileged few. Charles-Michel de l'Épée (1712-1789) was the founder of the first French school for the deaf irrespective of their social condition. He gave instruction to two deaf sisters in 1760. In 1791 the school he founded and contributed to

FIGURE 3. Present day two-hand British finger spelling alphabet of the deaf.

from his own private income became the National Institution at Paris. The Abbé de l'Épée was acquainted with the system employed by Pereire and used the alphabet in instruction (*6*). Roch-Ambroise-Cucurron Sicard (1742-1822) became the head of the school in Paris after the death of the Abbé de l'Épée. The Abbé Sicard continued the use of the one-hand alphabet in conjunction with methodical signs. The manual alphabet employed by Sicard was, with only slight differences, the same as that used in the United States today (*12*). It was brought to this country by Thomas Hopkins Gallaudet (1787-1851). In 1815, through a subscription of funds, Gallaudet was sent to Europe for the purpose of qualifying himself to become an instructor of the deaf. He first went to London but was rebuffed at the London Asylum. He next went to Edinburgh, but the institution there was under obligation not to instruct teachers for a period of years. He had met Sicard in London and had been invited to Paris. So Gallaudet turned to Paris and the French system of instruction. He returned to the United States in August 1816, bringing with him Laurent Clerc, a deaf teacher from Paris who had been, incidentally, an outstanding pupil under Abbé Sicard. Thus were signs and the modified Spanish manual alphabet brought to America. The American School for the Deaf, as it is now called, was opened at Hartford, Connecticut, on April 15, 1817—the first permanent school for the deaf in the United States. Dr. Gallaudet was the first head of this school and served in that capacity for 14 years.

TWO-HAND ALPHABET

In Great Britain manual communication developed into a two-hand alphabet and continues as such today. After Bede, the earliest reference by any English writer to a manual alphabet was by John Bulwer, a physician. In 1644 he published in London the *Chirologia or the Natural Language of the Hand Composed of the Speaking Motions, and Discoursing Gestures thereof whereunto is added Chironomia of the Art of Manuall Retoricke*. He tells how a deaf man could converse with his wife at night by means of an alphabet contrived on the joints of his fingers. In this work Bulwer shows six manual alphabets (*J* and *U* are omitted) which are mixtures of one- and two-hand forms but show little relationship

to the two-hand alphabet that eventually became established in Great Britain. Dr. George Dalgarno (1626?-1687) of Scotland was the first English writer to advocate a manual alphabet for the deaf. In 1680 he published *Didascalocophus, or the Deaf and Dumb Man's Tutor*. Although he mentioned and rejected a two-hand alphabet somewhat similar to the one commonly used in Great Britain today, he advocated an alphabet he devised. This latter alphabet had letter points assigned to one hand which were designated by touching with the thumb or finger of the other hand. The vowels were on the ends of the fingers (*A* on the tip of the thumb, *E* on the tip of the index finger, *etc.*), which is characteristic of the present two-hand alphabet. But unlike the present-day alphabet, the remaining letters were located by pointing to the phalanges of the fingers and the palm of the hand.

Critchley (*4*) cites the alphabets advocated by La Fin (*8*) and Wilkins (*13*). In 1692 La Fin proposed an alphabet incorporating the old device of pointing to the various parts of the body combined with Dalgarno's device of the vowels on the tips of the five fingers. Similar to the mnemonic arrangement reported by Porta, La Fin used *B*-brow; *C*-cheek; *D*-deaf ear; *F*-forehead; *G*-gullet; *H*-hair, *etc.* As this alphabet was associated with the English language only, La Fin developed another for use in Latin.

The other citation by Critchley (*4*) is to Bishop Wilkins of Chester, who in 1694 advocated a manual alphabet similar to that of Dalgarno, using the tips of the fingers for the five vowels; the middle parts for the first five consonants; the bottom parts for the next five; the spaces between the fingers for the next four; *T*-one finger laid on the side of the hand; *V*-two fingers; *W*-three fingers; *X*-the little finger crossed; *Y*-the wrist; Z-the middle part of the hand.

The two-hand manual alphabet that eventually came to prevail in Great Britain is first found in a rare booklet, *Digiti Lingua* (*5*), published in London in 1698, which the author says is 'the most compendious, copious, facile and secret way of silent Converse ever yet discovered showing how any two persons may be capable in half an hour's time, to discourse together by their Fingers only, as well in the dark as the light.' There is no indication that the alphabet devised would be of use to the deaf although the anonymous author says of himself: 'By a person who has conversed no other wise in above nine Years.' He mentioned another alphabet in use that employed *A*-arm, *E*-elbow, *M*-mouth, *N*-nose, with most of the consonants about the head. He regarded his own system as more facile. The illustration given shows the vowels on the tips of the fingers as Dalgarno employed them and which are still used today. The consonants shown in *Digiti Lingua* are, with some modifications, very similar to those in the present-day two-hand British alphabet (Figure 3).

Farrar notes that the alphabet in *Digiti Lingua* is also described in Defoe's *Life of Duncan Campbell*, and that de l'Épée speaks of a two-hand alphabet as being well-known to French schoolboys in his time. In connection with the latter comment, it is interesting to note that hearing children in the United States frequently use a manual alphabet among themselves, but it is usually the two-hand English alphabet

(except they do not employ the tips of the fingers for the vowels). This is curious, inasmuch as schools for the deaf and the adult deaf in the United States have always used the one-hand alphabet. Apparently, whatever may have been the origin, the two-hand alphabet among school children is passed down through succeeding generations of children.

Farrar states: 'Many other finger alphabets, chiefly syllabic or phonetic —of the former, the French Recoing's in the early part of the last century, and of the latter, Grosselin's at a later time may be instanced—were formed for the deaf but . . . none ever acquired any permanent vogue . . .' (*6*).

Today, particularly among the adult deaf, there are some modifications in each alphabet, both the 1620 Spanish one-hand alphabet described by Bonet, now in use in the United States and continental Europe, and the two-hand alphabet shown in the 1698 *Digiti Lingua* employed in the British Isles. Although the one-hand alphabet is faster, the two-hand method is somewhat more 'gross' and hence more intelligible. Each is firmly established in its respective locality.

Summary

Manual signals as a means of communication are of ancient and uncertain origin. Hand alphabets have been in existence for more than a thousand years. The use of the manual alphabet in the formal education of the deaf is of more recent origin and was probably adapted from the practice of religious orders in observing vows of silence. A number of modifications which led to the establishment of the present one- and two-hand methods are described.

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Hearing Aid Evaluation: Reliability of Repeated Measurements

- *Irvin Shore*
- *Robert C. Bilger*
- *Ira J. Hirsh*

The purpose of evaluating hearing aids is to guide the hard of hearing person in the selection of an aid. Differences exist in the way such evaluations are conducted, but by and large they are still done in the manner described by Carhart (*2*, *3*, *4*) and Carhart and Thompson (*5*), dating back to 1946. In general, differences among aids are sought with respect to speech discrimination, gain, tolerance and noise thresholds.

In 1946 Davis and his associates (7) suggested that hearing-aid selection was not necessary in most cases but should be done when special problems become evident. They reported that most types of hearing loss could be benefited with hearing aids that had moderate high-frequency emphasis or uniform amplification. In 1949, Carhart (*6*) stated:

> One of the clinic's concerns must be with hearing aids and their use by cases seeking audiological help. The task includes training in adjustment to amplification, as well as the determination of a suitable instrument. Insofar as the selection of hearing aids for adults is concerned, the time should come when otology is exerting positive guidance by referring problem cases to hearing clinics and other cases directly to reputable dealers.

Now, a decade later, Newby (*8*) suggests that 'consultation' is better justified than 'selection'; but yet many hearing clinics continue to select hearing aids, not just for problem cases, but for all cases wanting advice.

Most of the adults seen in the Hearing Clinic at Central Institute for the Deaf appear not to require the extensive evaluation they receive, and we find that a good many of our hearing-aid recommendations are made on the basis of nonauditory factors like price, size and availability of service. These nonauditory factors seem to have importance even for those adults whom we consider to be problem cases. Further, in those instances where measurable differences do appear, we have questioned if they would remain differences were the tests repeated.

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Problem. A consideration of some of these problems raised by the clinic staff led to the following kinds of questions, many of which were considered to be amenable to investigation. First of all, we are seeking differences among hearing aids with respect to certain measures, but we know relatively little about the reliablity of these measures. How reliable is the measurement of hearing level for speech with a recorded list of spondaic words? This question must be asked in order for us to know how great a difference in the threshold, as measured with two hearing aids, should be regarded as interesting or informative. A similar question may be asked with respect to the discrimination score that is obtained with recorded phonetically balanced lists of monosyllabic words (*1*). How great a difference in the discrimination score obtained with two hearing aids is required before we can consider that the aids are really different with respect to discrimination? Futhermore, these two traditional measures of hearing for speech may not be exhaustive; there may be differences among aids with respect to the discrimination for speech against a background of noise.

Assuming that we have reliable measurements of several aspects of hearing for speech, then what factors about hearing aids may be shown to be related to these measurements? Are the aids themselves different from each other? Do the various combinations of tone settings on a particular hearing aid make a difference? Does the relation between the acoustical characteristics of the hearing aid and these auditory measures depend upon the type of hearing loss that the patient has?

Plan of Study. Questions of this kind led to the design of an investigation which can be described briefly as follows: Three diagnostic groups of patients with hearing loss were given a battery of auditory tests to determine the amount and kind of loss. Each of the patients was then tested with each of two tone settings on each of four different makes of hearing aids. Measures were taken of the aided hearing level for speech, the aided discrimination score for speech in quiet, and the aided discrimination score for speech in noise. All of these tests were repeated on four different days. The results for each patient were subjected to a statistical analysis in order to ascertain whether different hearing aids, different tone settings or different days of testing accounted for any significant differences in the results.

Procedure

Subjects. Fifteen adult patients, seen in the Hearing Clinic of Central Institute for the Deaf, were selected, five patients in each of three diagnostic groups: conductive, mixed and sensory-neural. All of the subjects had sufficient hearing loss to warrant the use of a hearing aid, were under 70 years of age, and indicated a willingness to come for lengthy testing on five different days.

Preliminary Audiometry. The first testing day was devoted to the following hearing tests, all without hearing aid: (1) pure-tone audiogram (air conduction and bone conduction); (2) monaural and binaural (field) hearing level for speech (speech reception threshold) with the CID Test W-2 spondee word lists, recorded; (3) monaural and binaural (field) dis-

crimination tests in quiet at 40 db above the speech threshold, with recorded PB lists (25 words each) spoken by Rush Hughes (*9*); and (4) monaural and binaural (field) discrimination tests in noise with the same recorded material at a signal-to-noise ratio of zero db; *i.e.*, the speech and noise were presented at the same over-all level, 40 db above the speech threshold, from the same loudspeaker.

Selection of Hearing Aids. Four well-known brands of conventional, on-the-body hearing aids, considered to be representative of the current market, were chosen from the stock in the CID Hearing Clinic. These four aids only were used for all 15 subjects. The clinicians selected, on the basis of specifications and information supplied by the manufacturers, the most appropriate tone and other internal settings for each patient. This setting was labeled *good*. The clinicians also selected the most inappropriate combination of settings for each patient, and this setting was called *bad*.

Not wishing to rely on the judgment of our clinicians alone, we sent the audiometric findings of the first 10 subjects, along with a short clinical description, to the four hearing-aid manufacturers. Each manufacturing company was asked to select the aid in its line which seemed applicable for each patient and also to specify the best internal and external adjustments on the hearing aid in question. The objectives of the study were discussed with representatives from each company and they were informed that this particular request was made in order to learn whether or not the hearing-aid companies and the hearing clinics would make similar recommendations.

Specific recommendations were received from two of the manufacturers and these were in such close agreement with our own recommendations that we decided to rely upon our own judgments for tone settings for the entire group of patients and the entire group of hearing aids. Further recommendations were received from a third manufacturer after this decision had been made, and in this case the recommendations were not in such close agreement with our own. We used, however, our own. The fourth manufacturer replied that the inconsistencies among the results for pure-tone loss, speech loss and discrimination scores represented inadequate clinical tests and that, therefore, he was unable to make specific recommendations.

Hearing-Aid Performance. The eight specific combinations of the four types of hearing aids with two tone settings, good and bad, were tried on each subject on each of four testing days. Each day's procedure was the same: (1) Unaided hearing level for speech (CID W-2) was measured in the field. (2) Each hearing aid was set so that the acoustic gain at 1000 cps was equal to the patient's hearing level for speech on that day. (3) The hearing level for speech, the discrimination score in quiet and the discrimination score in noise were measured on each hearing aid with the gain so set. (The order in which the eight combinations of hearing aid and tone setting were used was randomized.) (4) In addition, information was obtained with regard to the consistency of the patient's adjustment of gain for both comfortable and uncomfortable loudness and quality rat-

TABLE 1. Audiometric findings for individual patients.

	Patient Number	Years of: Age	Loss	HA Use	HL — Speech L	R	Field	PB — Quiet L	R	Field	PB — Noise L	R	Field	HA—Air-Bone Ear	Difference
Conductive	1	44	13	3	52	56	47	72	*80*	72	48	52	56	R	37
	2	43	18	3	41	42	38	96	*96*	76	60	68	60	R	25
	7	59	21	6	49	58	47	60	*76*	44	44	36	32	R	40
	8	46	24	7	62	48	45	76	*80*	64	52	48	8	R	29
	15	28	13	13	80	41	42	44	*76*	20	16	0	0	R	25
Mixed	9	56	21	10	46	28	29	*60*	76	64	44	36	32	L	37
	10	45	13	7	44	37	38	*76*	76	88	56	48	52	L	10
	11	50	8	5	37	36	35	*68*	76	72	48	20	44	L	22
	12	60	30	8	39	31	37	*60*	60	72	32	44	32	L	25
	13	29	10	8	41	37	40	*56*	76	60	36	44	0	L	48
Sensory - neural	3	66	7	1	36	43	37	12	*24*	32	0	12	16	R	0
	4	43	9	0	37	50	39	56	*40*	28	28	48	40	R	17
	5	67	13	3	40	39	42	12	*24*	28	4	8	12	R	0
	6	42	27	6	57	57	59	*0*	0	4	0	0	0	L	0
	14	47	9	4	49	70	55	*56*	48	16	32	16	8	L	20

ing of aids by the patient, but these results did not lend themselves to the quantitative treatment that we had hoped for.

These procedures are not very different from those that are ordinarily used in the clinical evaluation of hearing aids except for two important items: (1) repetition of the measurements on four different occasions, primarily for the purposes of this experimental study, and (2) the way in which the gain of the hearing aid was set. Most clinical procedures enlist the help of the patient in setting the gain so that the output of the hearing aid is comfortable. Since this was to be an experimental study, we decided to use a procedure over which the experimenters could have more control. It was reasoned that the patient's own hearing loss was described, to a first approximation, the amount of gain that he would require. Therefore, when the hearing-aid transmitter was placed upon the patient's body and a 1000-cps tone was presented to it from the test loudspeaker, the volume control of the aid was adjusted until the acoustic output of the hearing-aid receiver in a plastic 2-cc coupler was as many decibels greater than the level arriving at the hearing-aid microphone as the patient's threshold for speech was greater than normal.

INDIVIDUAL RESULTS

Audiometric Findings. An audiometric description of the 15 patients used in this study is shown in Table 1. The

patients were numbered as they came in and thus the numbering has been recorded for the purposes of classification. All but Patient 15 were female and most of them were of middle age, with three over 60 and two under 40. All of them had had trouble with hearing for at least seven years and two of them had had trouble with hearing for more than 25 years. All but one had used a hearing aid, most of them for more than several years.

We have not attempted to reproduce the thresholds for pure tones. Suffice it to say that there were no great discrepancies between the average pure-tone hearing level (500-1000-2000 cps) and the hearing level for speech, which is recorded in Table 1. The last two columns of Table 1 concern only the ear that was used for the hearing-aid tests. The difference between air-conduction and bone-conduction hearing loss is the average difference for the three frequencies mentioned above on that ear only. The discrimination score in quiet (PB lists) for the ear used in the hearing-aid study is in italics. These two factors, air-bone difference and discrimination score in quiet for the ear used in the hearing-aid tests, comprise the sole basis for diagnostic classification used in this study.

A comment about the discrimination results in the field is necessary. The maximum sound pressure level (db re 0.0002 microbar) available from our loudspeaker at the listener's position was 90 db. In the earphone tests, we always presented the PB lists 40 db above the threshold for speech. In the field, it was rarely possible to do this, and most of these discrimination scores were obtained with a sound pressure level of 90 db. For example, Patient 1 had a hearing level for speech in the field of 47 db, which corresponds to a sound pressure level of about 67 db. In order to deliver the PB lists 40 db above this threshold, they would have had to be presented at 107 db SPL, but our maximum was 90 db. This limitation in the maximum power available in the loudspeaker probably accounts for the fact that most of our discrimination scores in the field are lower than those obtained under earphones. This limitation did not apply when hearing aids were used because of the gain of the hearing aid.

Individual Hearing-Aid Performance. The data are discussed at two levels: (1) Individual raw data for two of the 15 subjects are presented and their day-by-day performance is examined in detail. (2) The performance of the 15 subjects averaged over the four testing days provides the basis for the discussion of the significant factors that produced differences within the scores of each patient.

The raw data concerning hearing-aid performance consisted of three kinds of measurement: (1) the gain or shift in hearing level for speech due to the hearing aid; (2) the discrimination score in the field in quiet; and (3) the discrimination score in the field with a background noise (same loudspeaker) that was equal in over-all level to the average level of the speech. There were 32 such measures for each of the three kinds of measurements for each patient. Each kind of measurement was obtained for each of the four hearing aids on both *good* and *bad* tone settings, on each of four separate days.

As an example of raw data, Table 2 shows the results of tests with hearing aids for Patient 7, selected because, as

TABLE 2. Hearing-aid performance: Raw data for Patient 7.

		Setting							
		Good				Bad			
		Hearing Aid							
Day	HL	A	B	C	D	A	B	C	D
		Gain							
1	44	54	34	33	43	37	36	37	40
2	43	36	40	39	42	36	34	35	36
3	41	32	35	33	35	34	35	27	39
4	38	34	44	35	35	37	22	34	33
Average	42	39	38	35	39	36	32	33	37
		PB — Quiet							
1		44	36	44	48	60	32	52	40
2		44	44	64	60	52	48	36	60
3		60	64	48	76	48	52	56	56
4		44	48	40	52	60	36	48	52
Average		48	48	49	59	55	42	48	52
		PB — Noise							
1		12	0	12	8	4	8	12	4
2		0	0	0	12	8	8	8	4
3		16	0	8	12	8	4	24	12
4		12	28	12	16	28	4	8	16
Average		10	7	8	12	12	6	13	9

will be shown later, the results for this patient showed no significant differences due to hearing aids, settings or days of testing. As Table 1 shows, Patient 7 was 59 years old and had a hearing level for speech of 49 db in the left ear and 58 db in the right ear on preliminary testing. For the right ear, the one that was used for hearing-aid tests, this patient had an unaided discrimination score of 76 per cent in quiet and 36 per cent in noise. This discrimination score in quiet, in conjunction with a difference between bone and air conduction of 40 db, places Patient 7 among the conductives.

Gain for Speech. Table 2 shows that on the first day of hearing-aid tests, the patient had a hearing level for speech in the field of 44 db. With the gain of the various hearing aids at 1000 cps set at 44 db, the gain or improvement in speech threshold realized through the various hearing aids is shown in the first row. The *good* setting on Hearing Aid A yielded a gain for speech of 54 db while the *good* setting on Hearing Aid C yielded a gain for speech of only 33 db. On the basis of gain alone, we might have selected Hearing Aid A, but it must be noted that this superiority was not consistent on all of the testing days. For example, on the fourth day, Hearing Aid B on the *good* setting gave a gain of 44 db which was the best gain on that day, in contrast to a gain of only 34 db (almost the lowest) for the same aid on the first testing day.

There appear to be differences

TABLE 3. Hearing-aid performance: Raw data for Patient 4.

		Setting							
		Good				Bad			
		Hearing Aid							
Day	HL	A	B	C	D	A	B	C	D
					Gain				
1	33	16	17	2	21	18	15	16	17
2	29	13	6	4	8	11	6	4	8
3	28	7	7	0	5	5	5	6	11
4	32	20	15	22	14	16	18	18	17
Average	30	14	11	7	12	12	11	11	13
					PB — Quiet				
1		56	40	20	48	28	20	60	20
2		32	28	52	48	64	56	52	72
3		56	28	32	40	60	64	56	64
4		68	44	48	72	48	48	52	36
Average		53	35	38	52	50	47	55	48
					PB — Noise				
1		20	8	20	16	24	20	28	20
2		28	28	48	32	36	40	24	32
3		48	36	32	40	48	32	32	40
4		40	24	28	28	44	24	44	40
Average		34	24	32	29	38	29	32	33

among the aids with respect to gain for speech on any one day, but the averages in the fifth row do not appear to be very different from one another. The significance of the differences among these averages emerges as one of the main effects in the statistical analysis; and for this patient the differences among aids are not significant. If we average across the rows, we get an average gain for all aids on each day. Differences due to testing day also turn out to be not significant for this patient. Furthermore, if we average all of the results for all aids for all days under the *good* setting and compare this average with a similar one for all conditions under the *bad* setting, we can evaluate the significance of the difference due to different tone settings. This difference turned out to be also not significant for this patient.

Discrimination in Quiet. A similar inspection can be made of the second part of Table 2. The unaided discrimination score on the right ear was 76 per cent and this amount of discrimination was realized through a hearing aid only once, on the third day with the *good* setting of Hearing Aid D. Otherwise, hearing aids appear to depress the discrimination score. On the first testing day, we might select the *bad* setting of Hearing Aid A as the best for discrimination but this superiority does not persist on succeeding days. The audiologist should consider that the comparative results that he obtains on only one day from a group of hearing aids are represented by one row in this table, while the other rows represent what might happen were he

to test again on other occasions. As will be seen below, these discrimination scores in quiet were not significantly different for different aids, for different days or for different tone settings.

Discrimination in Noise. The hearing aid appears to have an even more deleterious effect on discrimination in noise. Patient 7 obtained a discrimination score of 36 per cent unaided with a speech-to-noise ratio of zero db. This score is approached only twice in the hearing-aid tests, both times on the last testing day with the *good* settings of Hearing Aid B and the *bad* setting of Hearing Aid A. But again the overall differences among aids, among days or between tone settings, turn out not to be significant, even though they may appear to be real differences when we consider only one testing day.

A similar sample of raw data is shown in Table 3 for Patient 4, who was selected because the statistical analysis showed significant differences, at least for the discrimination in noise due to different testing days and for discrimination in quiet due to an interaction between tone setting and days. This patient is 43 years old, has a hearing level for speech of 37 db in the left ear and 50 db in the right ear. On the right ear, which was used for the hearing-aid tests, she has a discrimination score in quiet of 40 per cent and in noise of 48 per cent. The results with hearing aids appeared different from one another on any given day with respect to all three factors: gain, discrimination in quiet and discrimination in noise. When averaged over four testing days, however, these differences among hearing aids are not significant. There is a significant difference due to testing days for discrimination in noise. This difference is found if we average across all hearing aids and tone settings for each of the four days. The scores on the first day appear on the average to be much lower than those on the following days, and this significant difference appears to show something like learning to listen to speech in the presence of noise. There is also a significant interaction between tone setting and days for discrimination in quiet. This interaction can probably be explained by inspection of the second part of Table 3, where we see that three out of the four hearing aids on the *bad* setting give low discrimination scores on the first day. This low score is not characteristic of more than one hearing aid on the first day with the *good* setting. Thus we have a significant effect due to testing days that shows only for the *bad* setting, not for the *good*.

We have seen in the raw data for two patients, one conductive and one sensory-neural, scores representing hearing-aid performance for different aids and different tone settings on four different testing days. Patient 7 was selected because she is typical of a group of individuals who show no significant differences for the different hearing aids, for different tone settings or for different days of testing, on any of the three measures of hearing-aid performance. Such a result can be stated only after we look at the effect of repeating these tests on as many as four days. We might have missed this result had we looked only

TABLE 4. Hearing-aid performance for individual patients.

Patient	Original H L	Tone Setting	HL for Speech: Aids A	B	C	D	Significant Effect*	Discrimination in Quiet: Aids A	B	C	D	Significant Effect*	Discrimination in Noise: Aids A	B	C	D	Significant Effect*
1	39	Good	4	1	4	4	A	67	50	59	58	a, sd	21	26	26	23	
		Bad	3	3	10	1		65	54	60	57		19	18	22	17	
2	27	Good	–4	5	4	0	D, A	76	64	73	65		21	31	31	23	sd
		Bad	–4	8	–1	–4		64	67	75	51		28	32	34	27	
7	42	Good	2	3	6	3		48	48	49	59		10	7	8	12	
		Bad	6	–2	8	2		55	42	48	52		12	6	13	9	
8	37	Good	–1	2	2	5	d	54	44	61	53		18	13	17	19	D
		Bad	0	0	2	0		63	49	56	59		25	22	17	22	
15	34	Good	3	1	9	6	D, A	43	31	31	45	a	10	9	6	5	
		Bad	2	3	8	0		46	34	13	41		9	6	7	7	
9	29	Good	10	10	11	10		68	65	60	63		46	38	44	50	
		Bad	12	8	10	11		71	63	61	72		52	39	50	50	
10	36	Good	–2	–1	11	–2	D, A	65	63	63	66	A, a, as	31	27	34	29	
		Bad	2	2	6	–2		64	56	29	65		25	27	23	29	
11	35	Good	–3	0	3	–2	a	64	52	46	60		17	17	17	11	D
		Bad	–3	0	–1	–1		56	52	55	55		15	10	15	17	
12	27	Good	4	4	5	4		54	59	52	60	A, AD, as	16	19	21	24	
		Bad	2	8	8	10		57	57	31	62		23	33	18	25	
13	36	Good	6	8	13	6	S	59	48	57	61	a, as	30	16	39	16	
		Bad	5	4	5	5		70	61	32	66		37	23	24	22	
3	27	Good	1	4	4	3		19	29	25	28		3	5	6	5	
		Bad	2	2	1	4		31	25	31	29		8	6	4	3	
4	30	Good	16	19	24	19		53	35	38	52	SD	34	24	32	29	D
		Bad	18	20	20	17		50	47	55	48		38	29	32	33	
5	32	Good	2	4	10	4	A	48	36	40	45	S	8	9	11	10	
		Bad	2	7	9	7		23	28	45	31		7	8	10	11	
6	55	Good	10	10	30	26	d	1	0	0	1		0	0	0	1	
		Bad	20	8	20	20		1	1	0	2		0	0	0	0	
14	51	Good	2	3	2	5	S	43	32	22	48	S	10	5	4	7	
		Bad	4	11	9	3		37	24	16	33		11	8	10	3	

* Significant sources of variance are identified by appropriate letters: *D* for days, *A* for aids, *S* for settings; capital letters for 1% level and lower-case letters for 5% level of significance.

at the results of one day of testing. The two patients shown in Tables 2 and 3 are not meant to be typical of the entire group of 15 subjects; rather their raw data have been presented so that the reader can see the kind of information that was used as a basis for the averaged data.

Averaged Hearing-Aid Performance. The average measurements for each patient, for each aid and each tone setting over the four testing days, appear in Table 4.

Hearing Level for Speech. In addition to the original hearing levels for speech measured in the preliminary session (Table 1) the unaided hearing level for speech was measured at the beginning of each of the four testing periods in which hearing-aid performance was obtained. The average of four such measurements on the four days is given in the second column (Original HL) of Table 4. (Note that the entries are 'Hearing Level for Speech' in Table 4, while the corresponding numbers in Tables 2 and 3 were 'Gain.' The numbers for 'Gain' in Tables 2 and 3 were obtained by subtracting the aided hearing level for speech for each aid from the unaided hearing level for speech that was measured on each particular day.) This hearing level, measured immediately before the hearing-aid trial, was used as the basis on which to set the acoustic gain of the hearing aid at 1000 cps. If this set gain were realized perfectly in terms of the appropriate shift in hearing level for speech, then all of the entries under the first main section of hearing-aid performance would have been zero. The numbers in this section show how well this gain was realized. For example, if the speech threshold for Patient 1 had shifted by 39 db, the acoustic gain that was set in the hearing aid, then we should expect to find zeros. Instead, we note that this patient, over four days with Hearing Aid A with a *good* setting, had a residual hearing level of four db, or an average gain for speech of only 35 db. Some of the patients showed a gain for speech that was greater than the acoustic gain set at 1000 cps; *e.g.*, Patient 2 showed a residual hearing level of –4 on both *good* and *bad* settings of Hearing Aid A, indicating a gain for speech of 31 db from an acoustic gain at 1000 cps of only 27 db.

Scanning this first main section for hearing-aid performance up and down, one notices that patients vary in the amount by which they achieve for speech the acoustic gain at 1000 cps that was set in the hearing aid. In general, the five conductive cases at the top show least residual hearing level for all aids, while the five sensory-neural cases at the bottom show most. Our concern here, however, is not with differences among patients but rather with the differences for individual patients due to different days of testing, different hearing aids and different tone settings. The statistical analysis, to be detailed below, reveals which of these three main effects are significant. We have attempted to summarize the results of this statistical analysis before describing it by appropriate abbreviations in the column labeled 'Significant Effect.' For Patient 1, for example, there are significant differences in gain or residual hearing level among the hearing aids at the one per cent level of significance, but there are no significant differences attribut-

lower-case letters for 5% level of significance.

able to different days of testing or to different tone settings. Patient 8, on the other hand, shows significant differences for gain due to days of testing at the five per cent level of significance, but no significant differences among hearing aids or between tone settings. To take one further example, Patient 14 shows significant differences in gain due to tone setting at the one per cent level of significance, but there are no significant differences among hearing aids or among days of testing.

Discrimination in Quiet. Casual inspection of discrimination scores with the various hearing aids, averaged over four days (Table 4), reveals that there are very few substantial differences among hearing aids, although there are differences among patients. The significance of the several possible effects studied here is again coded in the column under 'Significant Effect.' Patient 15, for example, shows differences for discrimination in quiet among hearing aids at the five per cent level of significance, but there are no statistically significant differences attributable to different days of testing or to different settings. Patient 12, on the other hand, shows significant differences due to aids at the one per cent level and also shows two significant interactions: Aids x Days at the one per cent level and Aids x Settings at the five per cent level. These effects mean not only that there are significant differences for this patient among the hearing aids, but also that the differences among hearing aids depend upon the day the test was carried out and that the differences among aids depend selectively upon tone setting. This is one case that will be referred to in the statistical analysis as showing a significant main effect due to hearing aids that is largely attributable to the very poor score obtained on the *bad* setting of Hearing Aid C, the other seven scores not being very different from each other. There are several such examples in which a statistically significant effect appears to be attributable to a single *bad* score rather than to a whole group of very different scores.

When we compare the aided PB scores in quiet (Table 4) with the unaided PB scores (italicized in Table 1), we find that in eight out of the 15 cases the aided PB scores were significantly lower than the unaided scores. In the other seven cases, the aided PB scores were not different from the unaided scores. The eight patients for whom the aided PB scores were significantly lower included all five of the conductive cases, two of the mixed cases, and only one of the sensory-neural cases.

Discrimination in Noise. Table 4 shows similar results for discrimination in noise. Many of us, frustrated by small differences among aids with respect to gain or discrimination in quiet, anticipated great differences among aids in terms of their performance in noise. These results make startlingly clear the fact that there are no significant differences attributable either to different hearing aids or different tone settings for discrimination scores in noise. There is one interaction, significant at the five per cent level, for Patient 2, between settings and days; but if different tone settings depend upon the day of testing, then they cannot be very useful to the clinician who has only a single opportunity to test. The significant differences due to testing days for Patients 8, 11 and 4 indicate something like a

learning effect over the four days. Since Days do not turn up as a significant main effect for discrimination in quiet, we must assume that such learning is much more important for discrimination in noise.

Analysis of Results

Tables of such data as shown in Tables 2 and 3 were analyzed separately for each of the 15 patients. In general, the analysis-of-variance technique was used to discover whether the results for gain or residual hearing level for speech, for discrimination in quiet and for discrimination in noise were significantly different for different hearing aids, for different tone settings, for different days of testing, and for the several interactions among these main effects. Since the gain-score for each patient would depend in part on his initial hearing loss for speech on each particular day, the gain-scores were analyzed according to an analysis of covariance. The gain-score was obtained by subtracting the aided hearing level for speech from the original unaided hearing level for speech on that particular day. The acoustic gain of the hearing aid, as set for 1000 cps at the coupler, was used as the covariant. The discrimination scores, both in quiet and in noise, were analyzed by an ordinary analysis of variance. The discrimination scores in terms of percentage of words repeated correctly were transformed to arcsins before analysis. For each patient the difference between discrimination scores in quiet and noise was so large that it was necessary to perform separate analyses for the two conditions. The separate analyses were necessary in order to avoid violating the assumption of additivity required by the analysis-of-variance technique. The statistical design was identical for gain, discrimination in quiet and discrimination in noise. The effect of days was assumed to be random while the effects of hearing aids and tone settings were assumed to be fixed. In addition, the hearing aids-by-setting-by-days interaction was assumed to be zero so that the effects that involve days could be tested.

Gain. The analyses of covariance of the gains (HL for speech) obtained by the patients showed a significant difference among hearing aids for six patients (three conductive, two mixed and one sensory-neural). In four out of these six cases (two conductive, one mixed and one sensory-neural), the same aid that gives very poor PB scores for the *bad* setting also gives significantly less gain than the other three hearing aids. In the fifth case, a different aid gave significantly less gain than the other three; and, in the sixth case, two aids gave significantly more gain than two others.

Five patients showed a significant day-to-day variation in average gain (three conductive, one mixed and one sensory-neural). For two of the conductive patients, there was a tendency to get less and less gain from all hearing aids; and for the other three patients, there was a tendency for more gain from day-to-day for all four aids.

A significant difference was found between settings for one patient from the mixed category and one from the sensory-neural category. In both of these cases significantly greater gains were measured for the *good* setting than for the *bad* setting.

Discrimination in Quiet. With respect to discrimination scores in quiet, a significant difference among hearing aids was found for five of the 15 patients, two conductive, three mixed, but none of the sensory-neural group. Four out of these five instances of a significant difference among hearing aids can be attributed to the extremely poor discrimination scores obtained for the *bad* setting of one hearing aid, there being no difference among the aids for the *good* or recommended setting for these four patients. In the fifth case, there was a significant difference between the aid ranked first and the aid that ranked fourth with respect to PB scores, but not between the first and third or the second and fourth.

For three patients (one in the mixed and two in the sensory-neural categories), there was a significant difference between tone settings for the discrimination scores in quiet. This difference was in the desired direction; that is, the *good* setting gave higher scores than the *bad* setting. Days were not a significant source of variation for discrimination scores in quiet for any of the 15 subjects.

Discrimination in Noise. No significant differences were found between hearing aids for discrimination scores in noise. Also, there were no significant differences found between tone settings for discrimination in noise. A significant day-to-day improvement in discrimination in noise was observed for three patients, one in each of the diagnostic categories.

Interactions. In three cases of discrimination (one conductive in quiet, one conductive in noise and one sensory-neural in quiet), there was a significant interaction of setting and days. In these three instances, the *bad* setting gave significantly higher discrimination scores than the *good* setting on two out of the four days, while the *good* setting gave significantly higher discrimination scores on the other two days. The significant aids-by-setting interactions for discrimination in quiet that occurred in three cases were used to explain the differences among hearing aids earlier.

Statistical Summary. The data in Table 4 represent one level of abstraction away from the raw data since the results for individual days have been averaged. A further level of abstraction has been presented in the preceding paragraphs, where we have noted the number of significant effects attributable to either hearing aids, tone settings or different days. These effects were different depending upon the auditory measure used, whether gain for speech, discrimination in quiet, or discrimination in noise.

Discussion

We have not performed an over-all analysis for all patients, primarily because we were aware that conclusions about the efficacy of selecting among different hearing aids or different tone settings could not be discussed with reference to a group as a whole. Many audiologists agree that not all patients require careful selection procedures with regard to their hearing aids. Carhart (*6*), for example, has pointed out that the hearing clinic is most useful to the difficult cases who cannot simply

go and pick out a hearing aid by visiting various dealers. We have become accustomed, however, to thinking of problem cases as those that are primarily sensory-neural and have relatively low discrimination scores, *e.g.*, our third group. In view of this thinking that appears to have influenced audiology clinics for the past several years, it is somewhat surprising to find in this sample of cases that the predominance of significant differences attributable to different hearing aids resides in the conductive and in the mixed groups. It is somewhat disconcerting to realize that patients who seem to require the least care with regard to specific hearing-aid selection are the ones on whom the effects of different hearing aids are most evident.

Gain. The largest proportion of measurements that show significant differences are those that involve the hearing level for speech or gain. We do not know how far we can generalize about these findings because the procedure that we used to set the gain of the hearing aids, while much more precise than the usual procedure, was unorthodox. Actually we asked some of the patients to attempt to set the gain controls of their hearing aids so that conversational speech appeared to be comfortably loud and almost intolerably loud. The comfort settings would correspond more nearly to what is usually done in clinical procedures. These observations were not carefully enough controlled, nor were they made on a sufficiently large number of patients, to warrant definite conclusions. Those measurements that are available suggest that patients set the gain for comfortable loudness roughly in accordance with their hearing level for speech. As Table 4 shows, there are differences among the gains, but there are as many patients who show significant differences due to Days as there are patients who show significant differences due to Aids. The gain itself can be manipulated by the gain control and so is not crucial.

Discrimination. It is clear that although the discrimination scores in noise are very different from those in quiet, the additional noise test does not contribute any information about hearing aids. This conclusion is restricted to the conventional, monaural hearing aid and a testing situation in which both noise and speech come from the same loudspeaker. What differences there are among aids for discrimination in quiet appear to be concentrated in the conductive and mixed groups. The sensory-neural group, on the other hand, seems to be the one in which the effects of different tone settings are made evident. Discrimination in quiet seems to be the most important score for hearing-aid selection because results for gain depend so much upon where the gain control is set, and the results for discrimination in noise do not vary with aid or tone setting. But even the important discrimination score in quiet is not very useful as a predictor of the performance of different hearing aids because the effects of different aids or tone settings on different days of testing are significant for only about one-half of the patients in this study.

Which Is the Best Aid? This question is not always asked by the clinician; sometimes he may settle for 'Which aids are good and useable?' We may

look at a couple of examples in Table 4 to see what decisions we might make. Patient 7 appears to get the maximum gain for speech (that is, the minimum aided hearing level) with the *bad* setting of Hearing Aid B. But she gets the highest discrimination score in quiet with the *good* setting of Hearing Aid D. Furthermore, she does best in noise with the *bad* setting of Hearing Aid C. In deciding which of the two tone settings on which aid to recommend for her, we must not only attempt to weigh the relative importance of these three factors; but, what is more important, we must recognize that none of these differences was significant. For this patient, there is no evidence that the gains on the different aids or the different tone settings were any more different than they would have been had a single hearing aid with a single tone setting been used instead of these eight combinations. The same is true for the two discrimination measures. These measures are averages over four days and so they are more stable than a set of measurements for any one day. On any one day, some of these internal differences will be much larger and we might be led to the false conclusion that one of these single, large differences recommends a particular hearing aid. One must be very careful, before making such a recommendation, to ask himself how these apparent differences would hold up if he were to repeat this test on successive days. Indeed, this was one of the questions that led to the present study. If a hearing clinic devotes time to evaluating aids for the purpose of selecting a particular hearing aid, it must do so on the assumption that there are real differences among aids. Certain of the factors that differentiate aids are not easily quantifiable in the clinic, *e.g.*, judged quality, general workmanship, availability of maintenance service, *etc.* Among the factors that are quantifiable, the two most often mentioned are *gain* or change in hearing level for speech, and *discrimination score*. Our analysis shows that significant differences occur for these two quantifiable factors too seldom to warrant the tremendous amount of time that must be spent in acquiring the information. In short, the audiologist receives too little information for the amount of time that he must put in. We do not conclude that there are no differences among hearing aids (See Appendix); but we must conclude that whatever differences there are are not particularly evident in the three clinical measures that we have used in this study. If one wishes to maintain that there are real differences, then these differences must be sought among factors that have not yet been claimed to be measureable by the audiologist.

Summary and Conclusions

Fifteen clinical patients with mild or moderate hearing losses in three diagnostic categories—conductive, mixed and sensory-neural—were subjected to a series of extensive tests. Four popular brands of hearing aids were used, each aid being tested with both a *good* and a *bad* setting of tone and other internal controls. Tests of hearing-aid performance with all hearing aids and tone settings were repeated on four different days. Three auditory measures of hearing-aid performance were used: gain or residual hearing level for speech, speech discrimination in quiet, and speech discrimination in noise.

The results of all tests were analyzed statistically for each patient. Results of the analysis show that differences attributable to different hearing aids occur most often for gain (less than one-half of the subjects), less often for discrimination in quiet (less than one-third of the subjects), and not at all for discrimination in noise. Significant differences attributable to the tone setting occur for speech discrimination only for cases with sensory-neural hearing loss and only for certain hearing aids in about one-half of the other two categories of patients. Significant differences attributable to the day of testing are found for gain in less than one-half of the subjects but do not occur at all for speech discrimination in quiet. These differences due to testing day constitute the only significant differences found for discrimination in noise and then only for one subject in each of the three diagnostic categories.

This study was concerned with the reliability of three measures obtained in speech audiometry. It is concluded that the reliability of these measures is not good enough to warrant the investment of a large amount of clinical time with them in selecting hearing aids. Since the study was based upon the hearing aids used in ears whose hearing losses ranged from 37 to 58 db, it should be pointed out that extrapolation of such conclusions to cases with severe losses cannot be made without further study. Furthermore, this conclusion does not imply that there are no differences among conventional monaural hearing aids; but rather it suggests that whatever differences there might be are not detectable by these three usual measures of speech audiometry.

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Appendix

The main conclusion of this paper is that one does not find substantial or striking differences among the results of hearing tests obtained from patients using different hearing aids or different tone settings of hearing aids. This conclusion cannot imply that there are no substantial physical differences among hearing aids, because there is no good evidence concerning a relation between the performance of an aid as measured through listening tests and the physical performance of an aid as measured through acoustical tests. On the other hand, the possibility remained that, since we chose to use four good hearing aids that enjoyed rather wide use in the general population, we had only a restricted sample of hearing aids without any unusual or very bad ones.

In order to answer the question concerning differences in the acoustical performance of these hearing aids, we have delayed the submission of this report, the main results

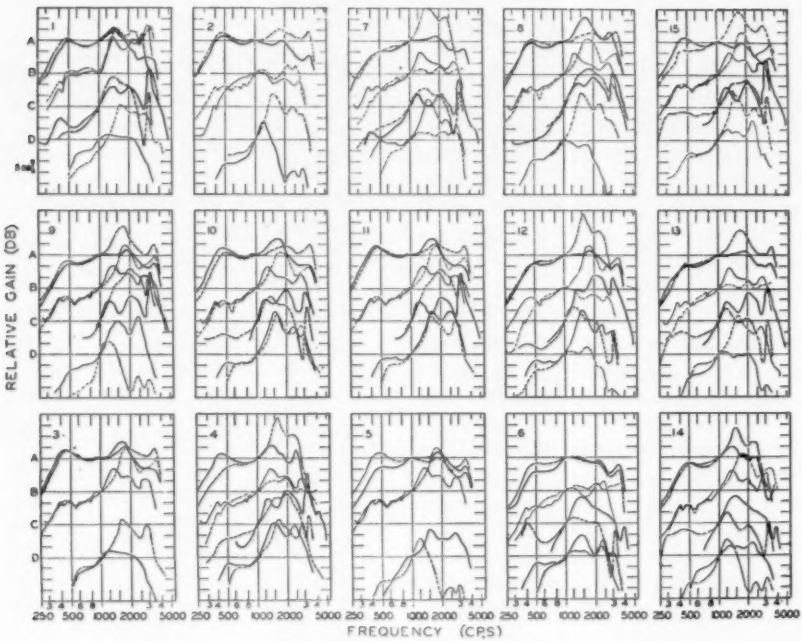

FIGURE 1. Response-versus-frequency characteristics of hearing aids used by each patient. The abscissa shows frequency on a logarithmic scale. The ordinate shows gain (5 db per marked step) relative to the gain set at 1000 cps. This set gain for each aid is placed on the horizontal line marked with the letter-name of the aid. Response curves for the *good* settings are indicated by solid lines, while those for *bad* settings are indicated by broken lines. The top row shows response curves for aids used by the conductive cases, the middle row those used by the mixed cases, and the bottom row those used by the sensory-neural cases. The number in the upper left of each set of curves corresponds to the patient numbers in Tables 1 and 4. (Curves for one hearing aid for Patients 2, 3 and 5 are missing, as explained in footnote 1.)

of which were presented to the Convention of the American Speech and Hearing Association in New York in November 1958, until certain physical measurements had been completed on the hearing-aid combinations used. To be sure, there are many kinds of acoustical measures that one can make on a hearing aid, but we have chosen to show only the gain or response of the hearing aid as a function of frequency. This is a conventional acoustical description of a hearing aid and in the future, it may turn out to be less important for predicting listening performance than other measures.

Method. Pure tones were transduced through a Western Electric 555 receiver (artificial voice) in a small anechoic chamber. A laboratory standard condenser microphone (Western Electric 640 AA) was placed six inches in front of the artificial voice and the response versus frequency curve for the artificial voice was thus obtained. The hearing aid transmitter was then substituted for the condenser microphone. The receiver of the hearing aid was connected to a 2-cc coupler so that its acoustic output could be measured by the condenser microphone. Three curves were obtained for each hearing-aid combina-

tion, one for each of three fixed gains at 1000 cps of 30, 40 and 50 db. The gain control of the hearing aid was adjusted so that the difference between the sound pressure level arriving at the hearing aid's microphone and the sound pressure level delivered by the hearing aid's receiver to the condenser microphone was 30, 40 or 50 db. From the response curve thus obtained on the hearing aid, the original calibration curve of the artificial voice was substracted, so that the result was a curve showing the gain of the hearing aid as a function of frequency. Such are the curves that are plotted in Figure 1.

Hearing Aids. The response of each hearing aid is different depending upon internal and external tone settings, kind of receiver, different inserts, and different cords. In assigning various combinations of these factors to each of the 15 patients, 13 different combinations for Hearing Aid A were used, seven for Hearing Aid B, 15 for Hearing Aid C, and 20 for Hearing Aid D. Fifty-five different response curves were required in order to have available the eight combinations that were used for each patient, that is, one *good* and one *bad* setting for each of the four hearing aids.[1] Not all of these combinations were used equally often for the different patients. For example, of the 13 combinations used for Hearing Aid A, four of them provided either *good* or *bad* settings for nine patients. Of the seven combinations available for Hearing Aid B, one provided the *good* settings for 11 patients while one other provided the *bad* settings for nine patients. Much more widely distributed use was made of the 15 combinations for Hearing Aid C and of the 20 combinations for Hearing Aid D.

Results. Instead of displaying the 55 different response curves associated with the various combinations of tone settings in the four hearing aids, we have chosen to present the eight response curves that were used by each of the 15 patients, two settings in each of four hearing aids in Figure 1. The ordinate scale is marked off in 5-db units. In order to minimize the interweaving and overlapping of the curves, they were separated so that the reference gain, *i.e.*, the gain at 1000 cps, is set at a different place on the ordinate scale for each hearing aid, the place being designated by the hearing aid's name letter at the left. Thus in the set of curves for Patient 1 in the upper left corner, the gain for Hearing Aid A is shown as a function of frequency relative to the gain at 1000 cps, which appears on the horizontal line marked 'A.' It will be recalled that the response of these hearing aids as a function of frequency was measured for three different fixed gains at 1000 cps, *viz.*, 30, 40 and 50 db. Since Patient 1 originally showed a hearing level for speech of 39 db, the 40-db curve was chosen for all hearing aids shown for Patient 1. Thus the reader knows that for Hearing Aid A (*good* setting), when the gain at 1000 cps was 40 db, the gain at 500 was also 40 db, the gain at 1500 was 45 db, and the gain at 3000 was 30 db. Similarly, for Patient 1, the horizontal line marked 'B' is 40 db for Hearing Aid B, *etc.*

There are some general features to note. First of all, Hearing Aid A, except in those circumstances where a peak was inserted (usually for a *bad* setting), shows the most uniformly flat response. Hearing Aids C and D, even with the permissible variations in tone setting, almost always de-emphasize the low frequencies and show much greater response for frequencies above 1000 cps. We cannot make any general statement about the effect of tone setting. For some hearing aids the changes from *good* to *bad* accomplish very little, as shown by the *good* and *bad* response curves for Hearing Aid A on Patients 1, 2, 10, 11 and 6, and also by the curves for Hearing Aid B on Patients 1, 2 and 4. On the other hand, sometimes the switch from a *good* to a *bad* setting changes things more drastically. In many cases the *bad* setting turns out to be the super-position of a high-frequency peak (curves for Hearing Aids A on Patients 7, 15, 9, 12 and 4). In other cases, the change in tone setting changes a broad, high-pass band either to a narrow peak or to a broad band with less gain (Hearing Aid D in Patients 1, 2, 8, 9, 12, 3, 5 and 14).

Comparisons with Performance Data. The above general comments plus some further time spent in looking at these curves indicate that there are substantial differences in the response characteristics of the different hearing aids and, for some hearing aids, between the tone settings. It does not appear, therefore,

[1] Two exceptions to these general statements must be noted. The model of Hearing Aid B that was used for Patient 1 was different from the one used with the other 14. Also a different model for Hearing Aid C was used for Patients 2, 3 and 5. Response curves for this model were not obtained and, therefore, only three pairs of curves are shown for these three patients (2, 3 and 5) in Figure 1.

that our restricted sample of hearing aids provided us with too homogeneous a group of response-frequency characteristics. Do these acoustical differences have something to do with the few differences that were observed in performance?

We shall eliminate from our consideration the question of obtained gain for speech because this quantity is manipulatable; *i.e.*, it can be controlled to a certain extent by the patient using his gain control. Also, we shall not consider discrimination in noise because there were no differences observed that could be attributed to either hearing aids or tone settings. This finding of no differences could well have been predicted even if there were great acoustical differences among the aids. If, for example, one hearing aid were extremely flat in response while another were peaked, both the noise and the speech would be filtered in the same way and thus might be assumed to provide the listener with the same information.

Of chief interest are the results for discrimination in quiet, shown in Table 4. Among the conductive patients, Patients 2, 7 and 8 showed no significant differences at all. The response curves for three of the four hearing aids used by Patient 2 reveal, however, that for this patient Hearing Aid A had a very wide, flat response characteristic, while Hearing Aids B and D showed gain rising with frequency up to 1200 or 1500 cps and then remaining either constant for frequencies above (B) or dropping sharply with frequency (D *good*). Patients 10 and 15 showed significant differences due to hearing aids, and there was a very bad performance in both cases for the *bad* setting of Hearing Aid C. Inspection of the curves used by Patients 10 and 15 in Figure 1 shows, however, that the response characteristic for the *bad* setting of Hearing Aid C is peaked at about 1500 cps, like that of the *bad* settings for Hearing Aids B and D, with which characteristics the patient appears to have done much better. The *bad* setting of Hearing Aid C appears to be involved in a single poor score for Patients 10, 12 and 13 (Table 4). The only thing that appears to stand out in this response characteristic is a sharp dip at 3000 cps as can be seen from its response curve (C, *bad*) in Patients 15, 10, 12 and 13.

One can reverse this inspection procedure and look first for great differences on Figure 1, *e.g.*, the rather drastic difference between the *good* and *bad* settings of Hearing Aid D for Patients 1, 2, 8, 9, 3 and 5. If these great differences in response characteristics of the two tone settings would have effects in discrimination score, we should see differences listed between the two scores, *good* and *bad*, under Hearing Aid D in the second main section of Table 4. But if one goes down the pairs of numbers under Hearing Aid D, he is struck with the similarity between the first and second number of each pair, the one exception being a difference of 14 per cent for Patient 2, in favor of the narrow peak or *good* setting.

In general, then, we see that what few differences there are in discrimination score cannot be tied up very well to differences in the acoustical gain of the hearing aid as a function of frequency. On the other side, there are great differences among the response characteristics of the hearing aids and between the tone settings of some hearing aids, but these differences only occasionally seem to be related to differences in performance as measured by the discrimination score. We are forced, therefore, to repeat the conclusion that preceded the Appendix, namely that our statistical results show only that there are not substantial differences in the performance of patients with different hearing aids on different tone settings, but this result does not imply that there are not acoustical differences among the aids themselves. In fact, there are.

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Paternal Occupational Class and Articulatory Defects in Children

- *Carl H. Weaver*
- *Catherine Furbee*
- *Rodney W. Everhart*

In a previous study, Everhart found no significant relationship between paternal occupation and maturation of articulation in 108 boys and girls in grades one through six (*2*). This was contrary to the conclusions of other research reports. Beckey, for example, reported that children with speech retardation are usually members of the lower occupational groups and that children whose parents are members of the professional and managerial groups more often demonstrate normal speech (*1*). Gesell and Lord (*4*) and Smith (*8*) also reported that speech maturation was superior in the upper occupational levels in the population samples they investigated. Irwin concluded that 'in general, speech development seems to be influenced by the occupational status of the family,' especially after the first year and a half of life (*5*).

Everhart attributed his failure to find this relationship to (1) the small size of his population and (2) the relatively homogeneous character of the single school from which the population was drawn. The school was located in the center of a housing area inhabited almost exclusively by workers in a large automobile factory. Consequently, the greater portion of his subjects fell into Classes III, V, and VI in the Minnesota Scale for Paternal Occupations. Only five boys and one girl with articulatory defects fell into Classes I and II. Even in the more heavily populated classes the N did not exceed 20, except in one cell.

Procedure

The purpose of this study was to re-examine this relationship in a large and representative sample. A previous research by the present writers investigated the relation between articulatory skill and reading readiness in a sample of 638 children in grade one during the first four weeks of school (*9*). One section of grade one was selected by the director of speech correction and the principal of each elementary school in Saginaw, Michigan, an industrial city of about 100,000 population. Care was

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TABLE 1. Distribution of parents of children with normal speech and children with non-normal speech across the Minnesota Scale for Paternal Occupations, and the U. S. Census distribution.

Class	Non-normal		Normal		Total	Theoretical
	N	%	N	%		
I Professional	15	4	17	11	32	21
II Semi-professional and managerial	26	6	24	15	50	49
III Clerical, skilled trades, and retail business	93	21	38	24	131	98
IV Farmers						104
V Semi-skilled occupations, minor clerical positions, minor businesses	150	34	52	33	202	168
VI Slightly skilled trades and other occupations requiring little training or ability	95	22	20	13	115	105
VII Day laborers of all classes	58	13	6	4	64	153
Totals	437		157		594	698

taken to select sections which seemed representative of each school population in socioeconomic level, race, intelligence and age. Before they had learned to read, the Gates Reading Readiness Test and a clinical articulation test were administered to these children and the occupation of the father was ascertained by the teacher.

It was found that the relationship between articulatory skill and reading readiness was highly significant. The difference between the 163 normal-speaking children and the 475 non-normal-speaking children was about 15 percentiles on the Gates Reading Readiness Test. The pattern of this relationship was exceedingly variable, however. The product-moment correlation coefficient (-.20) between the number of articulation errors and the reading readiness percentiles accounted for only four per cent of the variance among subjects. This finding is of some importance to the present study.

The clinical articulation test included both isolated words and connected discourse. An error was counted for each misarticulation in each position, making possible an error score of 66 on the so-called 'pure' sounds. In addition, 30 blends were tested, making a total possible error score of 96. Errors ranged in number from one to 78.

Of the 475 children with at least one articulation error, data on paternal occupation were obtained for 437. Of the 163 children without dyslalia, data on paternal occupation were obtained on 157. These 594 children constituted the population for this study. They were assigned to occupational classes according to the Minnesota Scale for Paternal Occupations (*6*).

RESULTS

The classification of the 594 children according to paternal occupation may be seen in Table 1, along with a theoretical classification projected from reports of the United States Census Bureau (*6*). The deviations of the present distribution were probably no greater than might be expected from the fact that the population sampled

TABLE 2. Mean number of articulation errors and mean reading readiness percentiles according to paternal occupational class distribution of 437 children with dyslalia.

Class	*Mean Number of Errors*	*Mean Reading Readiness Percentile*
I	7.6	72.67
II	11.3	72.12
III	9.6	64.73
V	9.1	59.20
VI	12.1	54.94
VII	13.1	28.48

was entirely urban and the city was highly industrialized, and from the possibility that the nation's industrial patterns may have changed since the scale was constructed. Class IV (farmers) was not represented in the present sample because the population was urban. These deviations were not considered a serious defect in the sample.

Inspection of the distributions of children with and without dyslalia (Table 1) reveals some differences. These differences were evaluated by chi-square, using proportions in order to equalize the sample sizes and applying a correction suggested by Garrett (*3*). The value for chi-square was 28.80 (five d.f.), significant at the .1 per cent level of confidence. This supported the reports of Beckey, Irwin, *et al.* (*1*), that speech maturation is generally related to class. Inspection of the percentages indicated in Table 1 shows that the normal-speaking children were placed somewhat more in the upper end of the paternal occupational scale, and that the children with dyslalia fell somewhat more often at the lower end.

In order to analyze this trend, the data for the 437 children with dyslalia were arranged within each class according to the number of articulation errors detected. The mean for each class, along with the mean reading readiness percentiles are presented in Table 2. Inspection of the reading readiness percentiles shows that as position on the occupational scale moved downward reading readiness fell off. The differences between adjacent classes were not significant except for the difference between Classes III and V, which was significant at the two per cent level of confidence. The sign test was used here and in later computations because the distribution of percentiles, while not rectangular, was not normal; and the distribution of articulation error scores was a Pearson Type III distribution (7). Thus the assumption of normality basic to the *t* distribution could not be met. The regular downward trend, however, can be attributed to the class relationship with some confidence. The differences tested were the smallest in the table. Futhermore, consistency is not one of the virtues of chance.

TABLE 3. Values for chi-square on the median sign test for differences between occupational classes in number of articulation errors.

Occupational Classes Compared	*Chi-Square*	*P*
I – II	.02	
II – III	.81	
III – V	.03	
V – VI	16.53	.001
VI – VII	.05	

The regular and expected relationship between occupational class and reading readiness was not so apparent between occupational class and the mean number of articulatory defects. Values for chi-square in the median sign test between classes are presented in Table 3. Only the difference between Classes V and

VI was significant. This suggested that within the non-normal-speaking group itself the occupational class of the parent had no significant effect upon the *severity* of the dyslalia except for the child whose father was classified VI or VII. Consequently, Classes I, II, III and V were combined and the difference between them and Classes VI and VII (combined) was evaluated by the median sign test. The value for chi-square was 41.42 (1 d.f.), significant at the .1 per cent level of confidence and suggesting that these two samples did not come from the same population. Since the occupational distinction between Classes I and II seemed of doubtful validity, because the number of subjects involved was relatively low, and because the reading readiness percentiles suggested linguistic equality, these two classes were combined, making an N of 41 subjects and a mean error score of 10.4. This combined group was not significantly different from Class III (chi-square = .09, 1 d.f.), nor from Class V (chi-square = .03, 1 d.f.).

Finally, an effort was made to select from the sample children who might approximate the subjects used by Beckey, *i.e.*, delayed speech cases. Subjects whose speech demonstrated more than 20 articulatory errors were assigned to occupational classes and a chi-square computed for the difference between their distribution and the distribution of the total sample. Despite the fact that these subjects were included in the total sample, the value for chi-square (15.68, 4 d.f.) was significant at the one per cent level of confidence. These children came predominantly from the lower end of the occupational scale. Population for the occupational classes was, in order, zero, five, 12, 13, 18, 10. This result tended to support Beckey's claim that children with delayed speech tend to come from lower socioeconomic levels. However, the division into occupational classes was probably not done here in the same way it was done by Beckey.

Discussion

These data suggest that occupational class is not evenly related to the degree of severity of articulatory defectiveness; *i.e.*, the number of defective sounds does not increase regularly (as reading readiness decreases) as position on the occupational scale falls. Instead, when Classes I and II were combined, the number of articulatory errors *decreased*, although not significantly, through Class V. Among the children who demonstrated at least one speech defect, the effect of paternal occupational status was negligible except when the father was a day laborer or worked at a job requiring little training or ability. It seems likely that some of the reasons suggested by Beckey may be operative here: More children from Classes VI and VII may inherit an inferior genetic endowment. They may have less opportunity for exposure to enlightening and stimulating cultural advantages. They may hear inferior patterns of articulation, *etc.* (*1*). It is interesting to note that whatever the factors are that tend to delay or inhibit speech maturation, they did not in this population seem to affect the speech of children whose fathers worked in semi-skilled or clerical occupations (Class V).

This seems to be contrary to one of the findings of Irwin, who found no significant differences in the rate of

acquisition of speech sounds between children whose fathers were skilled laborers and children whose fathers were unskilled laborers. Beckey grouped skilled, semiskilled and unskilled labor together and found significantly more delayed speech cases in the combined groups. It is likely that the conflict here is more apparent than real. The present study is based on the number of defective speech sounds, whereas Irwin's study was based on the number of speech sounds acquired. Beckey used only severe cases of retardation (alalia, infantile perseveration, babbling, jargon speech, hearing-mutism, and echolalia). Furthermore, Beckey's children ranged in age from two to seven years and Irwin's from about nine months to two-and-one-half years. The present study was confined to children in the first four weeks of grade one; their ages ranged from five years, eight months, to nine years, four months.

Neither Beckey nor Irwin revealed his technique of classifying children into socioeconomic groups or fathers into occupational classes. Since the present report used the Minnesota Scale, there may be some lack of comparability in this respect. Except for these apparent differences, the results of this study generally supported the claim that the occupation of the father is generally related to the proper speech maturation of the child. These data diverge rather sharply from previous reports, however, in restricting the inhibition or retardation of speech maturation in large part to the two lowest occupational classes.

Summary

The relationship between paternal occupational class and articulatory defectiveness was investigated in 594 first grade children. On the basis of the data, the following statements may be made: (1) Paternal occupational status is significantly related to early speech maturation. More children without dyslalia come from homes in the upper occupational groups, and more children with dyslalia come from homes in the lower occupational groups. (2) Only the two lowest occupational classes affect significantly the number of articulatory defects exhibited by children with dyslalia. This conflicts with the reports of Beckey, Irwin, *et al.*

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Functional Articulatory Defect and Performance on a Nonverbal Task

• *E. Philip Trapp*

• *Janet Evans*

Goldstein (*1*, *2*) and Spriestersbach (*6*), in their critical reviews of psychological research on functional articulatory disorders, concluded that, of the relatively few experimental studies published, the results were either conflicting or inconclusive. Of methodological significance was their discovery that not one of the studies surveyed stratified the *Ss* in terms of severity of articulatory defect, a finding which could be a major contributing factor to the prevailing confusion. As Spriestersbach (*6*) cogently pointed out, '. . . one is struck by the wide range of severity of articulatory defects frequently found in the groups studied. . . . it would be surprising, indeed, to find conclusive data on this question from the study of the usual "representative" sample of individuals with articulatory problems.'

There does seem to be little justification for treating all functional articulatory cases as a single homogeneous group, and it is the present authors' contention that this established practice has masked much significant data.

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Clinical observations on children with functional articulatory defects frequently detect the presence of excessive anxiety. If the severity of articulatory disorders is a function of anxiety level, then, on the basis of recent findings on anxiety-differentiated groups, *e.g.*, Spence (*5*) and Taylor (*7*), differential performances should be obtained between mild articulatory cases and severe cases on anxiety-producing tasks. This is the nature of the main hypothesis tested in the present study. More specifically, the study was concerned with a comparison of performances on the Wechsler digit-symbol subtest between children with mild articulatory defects and children with more severe defects. This nonverbal test was selected because of its recognized sensitivity to anxiety level (*9*). Since highly anxious *Ss* tend to do poorly on this test, it was hypothesized that severe articulatory cases would perform significantly lower than mild cases.

Method

Subjects. The *Ss* were 54 children, ranging in age from eight to 10, with a median age of nine (33 children were nine-year-olds). They were selected from the Kirkwood school system in

TABLE 1. Summary data on children with severe articulatory defects, mild articulatory defects, and normal speech.

Groups		*Trials* 1	2	3	4	5	*Combined trials*
Severe Defects (Group SD)	Mean Score	17.56	20.11	21.56	22.22	23.67	21.02
	SD	3.81	5.19	5.00	4.25	4.70	5.10
Mild Defects (Group MD)	Mean Score	21.44	22.94	24.17	24.89	25.22	23.73
	SD	4.25	5.48	5.38	5.08	4.82	4.65
Normal Speech (Group N)	Mean Score	19.83	20.72	21.83	23.06	23.00	21.69
	SD	3.53	4.08	3.05	3.97	4.28	3.18

Missouri and the Peabody Training School at the University of Arkansas. Three groups were formed, 18 *Ss* to a group with a sex proportion of 12 boys to six girls in each group. One group consisted of children with severe functional articulatory defects, a second group contained childen with mild articulatory defects, and a third group contained children with normal speech (the control group). The groups were matched with respect to age, sex, intelligence, and socioeconomic background. The children came mainly from upper-middle-class homes, with the educational level of the parents well above average. The median IQ for all three groups was 115, as determined by standardized group intelligence tests (California Test of Mental Maturity and Kuhlmann-Anderson Intelligence Test). Approximately a third of the *Ss* in each group were given the Wechsler Intelligence Scale for Children as a check on the reliability of the group scores, and no major discrepancies or biases were noted.

Procedure. The Templin Articulation Screening Test (*8*) was used as the criterion for determining severity of articulatory defect. The cutting score was 35. The scores for children with severe defects (Group SD) ranged from six to 35, wih median score of 28. According to Templin's norms, these children scored below her diagnostic cutoff point for five-year-olds. The children with mild articulatory defects (Group MD) had scores ranging from 40 to 46, with a median score of 43, which represented Templin's cutoff score for eight-year-olds.

The learning task involved five trials on an expanded form of the Wechsler digit-symbol subtest. The number of unfilled boxes totalled 75. Each child was taken to a quiet testing room where *E* presented the task in the manner outlined by Wechsler (*10*). The instructions were as follows:

> Look at the boxes or squares across the top of the page. See that each has a number on the upper part and a little mark on the lower part. Also that with every number there is a different mark.
>
> Now look at this sample test (point) just below this line. The upper parts of the boxes have numbers, but the lower parts are empty. I want you to put in each of these squares in the sample the little mark that should go there. (*E* helps the child understand the procedure and sees that he does the sample correctly.)

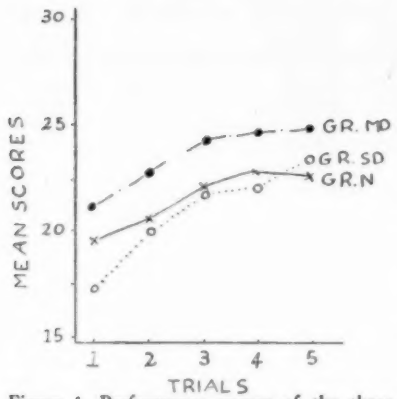

Figure 1. Performance curves of the three groups on the digit symbol task.

> Now when I tell you to start, begin here. (*E* points to the box at the top of the left column.) Do all the boxes on the left side of the page before starting on the right side. Also, do the squares one right after the other without skipping. It is important that you do it exactly in this way.
>
> There are 75 empty squares. You will be allowed just one minute to fill in as many as you can. Should you make a mistake, do not take time to erase; just go on with the next square.
>
> Now get set. (*E* has the child with pencil poised at the starting point.) Remember, you must stop the instant I say stop. Now go.

After the child has worked for the designated minute, a minute of rest is granted, during which time *E* counts the number of correct boxes filled and lets the child see the total. The child is then given a second sheet and gets set for trial two. The procedure is duplicated for all five trials.

Results

Each *S*'s score was determined by the number of correct boxes he filled within the time limit. Five sets of scores were recorded for each *S*, representing the five trials on the learning task. In addition, the average score for all five trials was computed for each *S*. Mean scores were computed for the three groups on each trial and for the combined trials. The summary data are presented in Table 1. In Figure 1, the performance curve of each group for the five trials is presented to facilitate comparisons between the groups.

The first statistical treatment of the data involved testing the significance of difference between group means on the combined five trials. Using the *t* test for matched groups, Group MD performed significantly higher ($P < .01$) than both Group SD and Group N (children with normal speech). The *t* values were 3.57 and 3.12, respectively. Group N did not perform significantly higher than Group SD (*t* value of 1.05; $P > .05$), although their mean scores were higher on four of the five trials. While Group SD reflected larger variability (Table 1), the differences between variances, as computed by the *F* test, were not significant at the conventional five per cent level.

Since the novelty of the task would be greatest on the first trial, which might make performance more susceptible to the influence of anxiety, the three groups were also compared on the first trial. With the *t* test as the statistical measure, it was found that Group MD scored significantly higher (*t* value of 5.12; $P < .01$) than Group SD. However, the differences between Group MD and Group N and between Group SD and Group N were not significant. Again, none of the groups differed significantly in variability.

Discussion

The major focus of the study was on the comparison of the performances

of mild functional articulatory cases and severe cases on a nonverbal learning task, and the results indicated a significant difference between the two groups both on the first trial and for all trials combined. The clear-cut superiority of Group MD validates the methodological criticism raised by Spriestersbach, and indicates the need to stratify *Ss* in terms of level of articulatory defect before studies can be meaningfully interpreted in this area.

The inclusion of Group N in the experimental design has provided a useful clue in understanding the insignificant results in many other related investigations. The key finding (Figure 1) was the inferior performance of Group N relative to Group MD, but its superior performance relative to Group SD. This suggests that anxiety had facilitating effect on performance up to a certain point, but an inhibiting effect beyond that point. This position is not inconsistent with other interpretations of the way anxiety may function, *e.g.*, Mowrer (*3*) and Shaffer and Shoben (*4*). If, in the present study, the combined scores of Group MD and Group SD had been compared with Group N, the findings would have been inconclusive. Therefore, it seems safe to assume that a number of other reported studies, having done essentially this very thing in their experimental design, had unwittingly masked or cancelled out significant trends.

As a point of caution in generalizing from this study, it should be remembered that the *Ss* were selected from above-average homes, particularly with respect to educational level of parents. Also, the age range of the children was rather limited. Nevertheless, the results do point up an important methodological consideration for future research in this area.

Summary

The hypothesis tested was that children with mild functional articulatory defects would perform significantly higher on a set of five trials on the Wechsler digit-symbol subtest than children with severe functional articulatory defects. Three groups of matched children, 18 to a group, with a median age of nine, were used: Group MD, representing mild articulatory cases; Group SD, representing severe cases; and Group N, representing a control group of children with normal speech. Level of severity of articulatory defect was determined by the Templin Articulation Screening Test. Group SD scored between six and 35 with a median of 28, and Group MD scored between 40 and 46 with a median of 43. Performances of the three groups were compared both on the first trial and for the combined trials by means of the *t* test. Group MD scored significantly higher than Group SD on both the first trial and the combined trials ($P < .01$), thus supporting the main hypothesis. Group MD also scored significantly higher than Group N with all trials combined ($P < .01$). The methodological implications of the findings were discussed.

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Articulation Skills of Adolescents and Adults with Cleft Palates

• *Donald T. Counihan*

For the most part, descriptions of the speech problem associated with the cleft lip and palate condition have been predicated upon clinical observation, and much of the information which has served as the basis for diagnosis and therapy has not been tested by research. Recently, formal studies (*2*, *5*, *6*, 7) have provided more accurate information than was previously available.

To the present time, however, there has not been a detailed and systematic description of the speech of adolescent and adult cleft palate persons. In cleft palate rehabilitation there is interest in the degree of speech sound efficiency achieved by cleft palate persons after closure of the lip and palate has been accomplished and after speech sound maturation has taken place. Consequently, the present study was undertaken to investigate the status of this group of cleft palate persons with respect to the correct production of consonant elements and certain consonant blends. This study is one part of a larger study of the relationship between speech efficiency and structural adequacy in cleft palate persons (*3*).

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Procedure

Subjects. Fifty-five subjects, 34 males and 21 females, ranging in age from 13 through 23 years, were selected for this study. The mean age of these subjects was 16.6 years. All types of cleft, with the exception of isolated cleft lip, were included. Thirty-two subjects presented complete unilateral clefts of the lip and palate; seven, bilateral complete clefts; and 16, isolated cleft palates. None of the subjects was judged to have defective intelligence on the basis of intelligence or achievement tests and none had a hearing loss greater than 20 db for frequencies within the speech range for the better ear.

The subjects were being, or had been, seen for care at the Northwestern University Cleft Lip and Palate Institute or the University of Illinois Cleft Palate Center. Forty per cent had received speech therapy for periods from six months to four years and 20 per cent had received more than four years of speech therapy. Five subjects were wearing speech appliances, and many subjects had received or were receiving orthodontic treatment. The sample represented the surgical efforts of more than 15 different surgeons.

Articulation Examination. The articulation test was designed to measure

the adequacy of 23 consonant elements and nine consonant blends in isolated words. Each consonant element was tested in three positions, with the exception of the [ð] and [w] sounds which were tested only in the initial and medial positions; the [h] and [j] sounds which were tested only in the initial position; and the [ŋ] sound which was tested only in the final position. The total number of consonants tested in all positions was 61. The nine consonant blends were those used by Bryngelson (*1*) and are blends of [s], [l] and [r]. Since these blends are mastered later by children, it was felt that they would provide a more rigorous test of the subject's ability to produce consonant blends correctly.

Judgments of the number and type of errors presented by each cleft palate subject were made by the writer. To establish the reliability of these judgments, the writer and two graduate clinicians who had had extensive experience with cleft palate persons recorded independently and simultaneously the speech sound responses of five cleft palate subjects. The writer agreed with the two other judges concerning the number and type of errors presented 90 per cent of the time. The two other judges agreed between themselves 91 per cent of the time. This level of reliability is similar to that reported by other investigators (*2, 4,* 7).

In recording responses for each subject for each sound tested, the following procedure was used: The test word was said by the examiner, and the subject was asked to repeat that word. If an error in production was noted, up to three similar words were used to determine further the type of error. If a sound was omitted or distorted, this was recorded. If a sound was substituted, the phonetic symbol for that sound was recorded. The special symbols [PF] for pharyngeal or velar fricatives, [G] for glottal stops, and [E] for nasal plosives were used. Sounds which were correctly articulated, but distorted by clearly audible nasal emission, were denoted by the symbol [IE]. This type of error will be referred to as 'indistinct emission.'

TABLE 1. Mean articulation scores and percentages of correct production for consonant elements when all consonant errors are considered and when all consonant errors except indistinct emissions are considered.

	*Articulation Scores**	*Articulation Scores†*
Number of sounds tested	61	61
Mean number of sounds correct	43.33	47.33
Standard deviation	13.10	10.42
Range	14–61	15–61
Per cent correct	71.03	77.62

* All consonant errors considered.
† All consonant errors except indistinct emissions considered.

RESULTS

Consonant Elements. The percentage and mean number of consonant elements correctly produced by the present cleft palate group are presented in Table 1. In Table 1 and in subsequent tables, the data are arranged to show: (1) scores for correct production when the total number of consonant errors is considered and (2) scores for correct production when all consonant errors, with the exception of indistinct emissions are considered. Thus, in the first analysis, indistinct-emission errors are treated as defective productions; in the second analysis, they are treated

TABLE 2. Percentage scores for the correct production of 23 consonant elements when all consonant errors are considered and when all consonant errors except indistinct emissions are considered.

Consonant Elements	*Per cent Correct**	*Rank*	*Consonant Elements*	*Per cent Correct†*	*Rank*
[j]	100.00	2.5	[j]	100.00	2.5
[h]	100.00	2.5	[h]	100.00	2.5
[w]	100.00	2.5	[w]	100.00	2.5
[m]	100.00	2.5	[m]	100.00	2.5
[ŋ]	91.52	5	[p]	98.79	5
[n]	89.70	6	[ŋ]	96.36	6
[ð]	84.54	7	[ð]	93.94	7
[b]	84.45	8	[ə]	92.73	8
[v]	81.82	9	[n]	90.30	9.5
[r]	81.21	10	[f]	90.30	9.5
[p]	79.39	11	[b]	89.09	11
[l]	78.18	12	[v]	88.48	12
[d]	75.76	13	[t]	84.24	13
[ə]	73.73	14	[r]	81.21	14
[t]	70.30	15	[l]	78.18	15
[f]	69.70	16	[d]	77.58	16
[k]	62.42	17	[k]	69.70	17
[g]	61.21	18	[g]	66.06	18
[dʒ]	47.27	19	[dʒ]	56.36	19
[ʃ]	46.26	20	[tʃ]	52.12	20
[tʃ]	42.42	21	[ʃ]	50 30	21
[s]	39.39	22.5	[s]	45.46	22
[z]	39.39	22.5	[z]	41.21	23

* All consonant errors considered.
† All consonant errors except indistinct emissions considered.

as correct productions. This procedure was followed because it was felt that subjects who articulate a sound correctly, even though that sound is accompanied by nasal emission, are demonstrating a higher level of articulation skill than subjects who omit, substitute or distort a sound by virtue of incorrect valving. Moreover, such an analysis tends to differentiate errors primarily related to velar inadequacy from those related to other disturbances of the peripheral speech mechanism. When all consonant errors are considered, the mean number of sounds correctly produced is 43, which is 71 per cent of the consonants tested. When all consonant errors except indistinct emissions are considered, the mean number of sounds correctly produced is 47, which is 78 per cent of the consonants tested. In both analyses there were relatively large standard deviations (13.1 and 10.4), and there was a wide range in articulation scores (14-61 and 15-61).

These findings indicate that there is a substantial increase in correct production when errors due to nasal emission are discounted. The findings also suggest that these cleft palate subjects perceived the correct manner of pro-

duction for many sounds which they did not produce successfully, but were prevented from achieving correct production by inadequate velar closure. McWilliams' assertion (*4*) that nasality and misarticulation are closely related in cleft palate speech is given support by the present findings. The substantial percentage of articulation errors, which were the direct result of audible nasal escape, affords at least a partial explanation for this relationship.

Correct Production of Individual Consonants. Table 2 presents percentage scores for the correct production of each of the 23 consonants tested. Percentages are reported on the basis of total consonant errors and total consonant errors minus indistinct emissions. Inspection of Table 2 shows that this cleft palate group had greatest success with the [j], [h], [w] and [m] sounds and least success with the [dʒ], [ʃ], [tʃ], [s] and [z] sounds. The rank order of success is generally similar to that reported for an older cleft palate sample by McWilliams (*5*). Table 2 also shows that there is an increase in correct production for many consonants when errors due to audible nasal escape are discounted. Further, certain consonants show a greater increase in correct production than do others. This can be seen in changes in the rank order of success for certain sounds. The [p] sound, for example, changes in rank from 11 to 5; the [f] sound from 16 to 9.5; and the [θ] sound from 14 to 8. To determine whether the consonants tended to maintain a similar rank when errors due to nasal emission are discounted, Spearman's rank-difference correlation was used. The results (rho=90) indicate

TABLE 3. Estimate of the level of articulation skill of the present cleft palate group based on a comparison of the subjects' percentage scores for correct production with the Templin norms.

Age cleft palate subjects resemble in articulation skills	*No. of cleft palate subjects**	*No. of cleft palate subjects†*
Below 3 years	19	11
3.0 to 3.5 years	2	2
3.5 to 4.0 years	9	9
4.0 to 4.5 years	2	3
4.5 to 5.0 years	4	4
5.0 to 6.0 years	5	9
6.0 to 7.0 years	2	3
7.0 to 8.0 years	2	1
8 years and above	10	13
Total Number of Subjects	55	55

* All consonant errors considered.
† All consonant errors except indistinct emissions considered.

that the rank order of success remained generally similar. The wide range in correct production which remains between sounds ranked highest and lowest, when indistinct emissions are discounted, suggests that other factors, in addition to velar adequacy, must account for the differences in correct production among the individual consonants. It seems reasonable to assume that these differences are in part related to other disturbances of the peripheral speech mechanism.

Level of Articulation Skill. To estimate the level of articulation skill attained by these cleft palate subjects, percentage scores for each cleft palate subject were compared with mean percentage scores for the correct production of consonants for 'normal' children by age, according to the Templin norms (*8*). The percentages for both the cleft palate and 'normal' group represent the percentage correct of the total number of consonants tested. Ta-

ble 3 presents these data. When all consonant errors are considered, 19 cleft palate subjects presented percentage scores which were less than the mean score attained by Templin's three-year-old group and 10 subjects presented percentage scores which were equal to or greater than the mean score for the eight-year-old group. When indistinct emissions are discounted, 11 cleft palate subjects had percentage scores which were less than the mean score for the three-year-old group, and 13 had percentage scores which were equal to or greater than the mean score for the eight-year-olds. These findings indicate that, even when errors due to velar inadequacy are excluded, one-fifth of the cleft palate group displayed less successful articulation than the average three-year-old normal child. Since the Templin norms do not extend below three years, it was not possible to compare percentage scores for cleft palate subjects which were well below the mean score for three-year-old normals. The findings also show that less than one-fourth of the cleft palate group attained or exceeded the level of articulation of Templin's eight-year-old group. If the articulation of Templin's eight-year-old group is held to be 'normal' speech, relatively few cleft palate subjects achieved this level of success.

In comparing the articulation of the cleft palate group with that of Templin's eight-year-old group, it should be noted that the mean percentage of correct production for the eight-year-olds was less than 100 per cent, *i.e.*, that all consonants tested were not correctly produced. If one defines 'normal' speech as the correct production of 100 per cent of the sounds tested, very few cleft palate subjects attained this level. Although not shown in Table 3, only five of the 55 cleft palate subjects correctly produced all of the consonants tested, even when indistinct emissions are discounted. The extent of retardation in articulation skills is better realized when it is noted that more than half of the cleft palate subjects evidenced poorer articulation than the average five-year-old normal child. This is true even when cleft palate subjects are credited with errors which occur primarily as the result of velar inadequacy. Considering the fact that these subjects had received many of the benefits of habilitation, the articulation deficit may be regarded as severe.

TABLE 4. Percentage scores for the correct production of nine two-consonant blends.

Sound blend	*No. correct*	*No. of blends tested*	*Per cent correct*	*Rank*
[bl]	41	55	74.54	1
[pl]	40	55	72.73	2
[dr]	37	55	67.27	3
[tr]	36	55	65.45	4
[kr]	35	55	63.64	5
[kl]	26	55	47.27	6
[st]	22	55	40.00	7
[sk]	21	55	38.18	8
[sl]	18	55	32.73	9
Totals	230	495	Mean 55.76	

Consonant Blends. Table 4 presents percentages of correct production for each of the nine consonant blends tested. The data reveal that the mean percentage of correct production for these blends of [s], [l] and [r] is 56 per cent. Inspection of Table 4 indicates that blends involving the [s] sound presented greatest difficulty, followed in order by those involving the [k]

sound in combination with [r] and [l]; the [t] and [d] sounds in combination with [r]; and the [p] and [b] sounds in combination with [l]. It might be expected that the subjects would have greater difficulty with these consonant blends, in that they are weighted with sounds which are difficult for cleft palate persons. The fact, however, that almost one-half of the blends tested were incorrectly produced attests to the severity of the articulation problem.

Summary and Conclusions

The speech of 55 operated cleft palate persons, 13 through 23 years of age, was studied with respect to the correct production of 23 consonant elements and nine consonant blends. The mean age of the cleft palate group was 16.6 years. All types of cleft except isolated cleft lip were included. None of the subjects were judged to have defective intelligence, and the subjects had essentially normal hearing. The sample represented the efforts of more than 15 different surgeons.

Percentage scores for correct production were computed for each subject and for each of the sounds tested. The data were arranged to show scores for correct production when errors due to clearly audible nasal emission were included and when they were discounted. The data were analyzed to show: (1) the percentage of sounds tested which were correctly articulated by the cleft palate group, (2) percentages of correct production for each of the 23 consonants and nine consonant blends tested, and (3) a comparison of percentage scores attained by the cleft palate subjects with the Templin norms.

The following conclusions appear warranted: (1) The cleft subjects had marked difficulty with consonant elements. Seventy-one per cent of the consonants tested were correctly articulated. (2) Nasal emission appeared to be a significant factor in the misarticulations of the cleft palate subjects. A substantial number of consonant errors represented sounds correctly articulated but distorted by clearly audible nasal emission. (3) Sounds misarticulated more than 40 per cent of the time were, in order of difficulty, [z], [s], [ʃ], [tʃ] and [dʒ]. Sounds correctly articulated 100 per cent of the time were [j], [h], [w] and [m]. The wide range in correct production which remains when errors due to nasal emission are discounted, suggests that other factors, in addition to velar adequacy, must account for differences in the level of success of the individual consonants. (5) When compared with the Templin norms, the cleft palate subjects were seriously retarded in articulation skills. More than one-half of the subjects presented poorer articulation scores than the average five-year-old normal child. (6) The cleft palate subjects had, on the whole, greater difficulty with the consonant blends tested than with the single consonant elements.

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Servo Theory and Stuttering

• *Edward D. Mysak*

This servo theory discussion of stuttering symptomatology represents the second in a series of projected articles concerned with the description of various speech and language disorders and their therapies viewed in terms of the oral language mechanism as an *open (inter-system)* and *closed (intra-system) cycle* servosystem. The first article (*8*) introduced the concept of a servo model for speech therapy and used an outline of *servotherapy* for articulation problems as the point of departure. For clarification of servosystem terms and expressed references to various parts of the servo model in the present paper, the reader should consult the previous article.

Definition

According to the concept of the oral language mechanism as a *closed* and *open cycle* servosystem, stuttering, or the disruption of normal speech fluency, is considered a disorder of *verbalizing*[1] *automaticity* or, therefore, *verbalizing deautomaticity*. It is proposed that this term is substantially more meaningful relative to suggesting related theory and practical concepts than is the superficial, descriptive term of stuttering.

Inspection of the servo model of the *total communication system (8)* reveals that there are at least four important self-reflexive *circuits* where *verbalizing automaticity* mechanisms may be disturbed, and which may eventually, directly or indirectly, reflect symptomatology that could be considered as stuttering.

Integrator Unit or Perceptual-Conceptual Mechanism Circuit. This unit has recently been described by Penfield and Roberts (*9*) as developing in the individual from series of sensory experiences or perceptions which are gradually distilled into concepts. (There is a continuous reciprocal relationship, according to Strauss (*10*), between percept and concept which results in continual concept-percept refining.) Often during these sensory experiences, they explain, words were heard in association and, consequently,

[1]Verbalizing in this paper refers to Penfield and Roberts' (*9*) description of the term as used by Jackson (*11*). It is seen as a dual process made up of speech and perception. Accordingly, speaking involves (a) exciting certain concepts in the system which (b) automatically and reflexively excite patterns of corresponding words which (c), in turn, after release by the volitional mechanism, eventuate in motor speech. Listening, or the reverse process, involves the reception of a stream of afferent impulses which exerts its patterned effect upon the speech mechanism, activates ganglionic counterparts of the words and then, as each word complex is activated, reflexively excites the corresponding concept.

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'as time passes there is formed within the brain the ganglionic equivalent of a word and the ganglionic equivalent of a concept.' Penfield and Roberts continue, 'One must suppose, then, that concepts are selected by action of the centrencephalic system,[2] and that the resultant activation of each concept brings up in turn the patterns of corresponding words by acquired automatic reflex action. Following this, the centrencephalic system sends forth the patterned stream of impulses that ends in speech or writing.' Reception of speech would constitute a reverse of the process decribed above. 'The connection between speech mechanism and concept mechanism is evidently reflex and automatic.' According to these authors, to verbalize one 'presents' a concept to the speech mechanism which results in the automatic excitation of motor speech.

With these ideas in mind, it becomes tenable that speech fluency may be affected from a disturbance of the reflexive and automatic relationship between the concept and word mechanisms, or referring to the servo model, by a break in the *circuit* between the *storage* and *governor* components. It may be hypothesized that if certain individuals or various social or speaking situations *(open cycle signals)* excite concepts that disturb the balance of the *total system, automaticity* deterioration between the concept and word mechanisms, or some form of stuttering behavior, may occur.

Controller Unit or Secondary and Primary Motor Speech Circuit. At least two reflex and automatic mechanisms are found in the *controller unit.* One exists between the *governor,* or secondary motor speech area,[3] and the *mixer-effector* complex, or primary motor speech unit; the second exists between the *comparator* and the *governor* and involves the development in the *comparator* of a predicted *fluency error signal* for particular *articulatory cycles.*

Relative to the first possibility, some anomaly of the motor speech and related areas may cause uncontrolled release of electrical potentials and disturb the *governor* and *mixer circuit.* Along these lines, Penfield and Roberts (*9*) state that hesitation, slurring, distortion and repetition of words and syllables occur when various areas of the brain are interfered with by electrical stimulation. The second possibility, or the creation of a *fluency error signal* in the *comparator* by an outside source, may similarly disturb the *total system* and eventuate in some type of stuttering.

Sensor Unit Circuit. Sensor unit deautomaticity is a *peripheral circuit* involvement as compared to the afore-

[2] '. . . all those areas of subcortical gray matter (together with their connecting tracts) which serve the purposes of inter-hemispheral integration and intra-hemispheral integration. We will continue to assume, therefore, that there is a central integrating system situated within the higher brain stem. Integration reaches the highest level there, in the sense of Jacksonian philosophy, but it is presumably never divorced from the activity of some areas of the cortex and especially certain areas of the temporal lobes and the anterior portions of the frontal cortex.'

[3] Penfield and Roberts suggest that this area should now be thought of as a cortico-thalamic unit whose cortical areas (regardless of handedness, almost always located in the left hemisphere) include not only the traditional Broca's area, or the anterior aspect, but also superior and posterior aspects, or supplementary motor and temporo-parietal areas, respectively. The latter aspect is considered the most important.

mentioned *central circuit* involvements and is associated with motor speech feedback delays. There have been series of experiments (*1*, *4*) which have indicated that delayed auditory sidetone may result in stuttering symptomatology. It is conjectured that aberrations in bone conduction, the organ of Corti as well as the auditory pathways, may produce conditions that simulate experimental delay times and which may result in similar fluency anomalies.

In substance then, it is believed that fluent verbalization depends on the integrity of a series of reflex and automatic language processes and this belief accentuates the importance of the principle of the *unity* of the *open* and *closed cycle linguistic circuitry*. This principle has three aspects, which are analogous to those listed by Meader and Muyskens (7) in their discussion of the unity of the organism, including relativity, self-reflexiveness, nonelementalism and unitary structure. In order, these concepts signify (a) that all parts of the *inter-* and *intra-system linguistic circuitry* are interrelated, (b) that every part tends to influence every other part, (c) that no part of the *total system* can be fully understood in isolation, and (d) that an understanding of each part in its relation to the other is essential to the understanding of the *total system.*

Theories and Verbalizing Circuitry

Certain interesting relationships may be seen and further inferences drawn when comparing *verbalizing deautomaticity* as a result of breaks in different parts of the *total linguistic circuitry* with constructs of some noted theorists of stuttering. It should be stated that descriptions of their theories and therapies as well as servo theory and therapy comparisons will be general and simplified. The ideas of Johnson (*5*), Sheehan (*3*) and West (*3*) were chosen for this discussion.

Johnson's Diagnosogenic Theory. Basically, Johnson (*5*) argues that stuttering develops when laymen, usually parents, diagnose as stuttering the normal nonfluencies of early childhood. This, according to Johnson, then precipitates actual stuttering.

In terms of servo theory, this type of etiology may be seen to be related to the previously described *circuit* break between the *comparator* and *governor* components. For example, let us imagine an individual verbalizing at an early age and experiencing the average number of syllable, word and phrasal repetitions, or *control point* disruptions. Now, if during his speaking performances another *communication system,* in the form of parents or other interested adults, emits language signals such as words, gestures or facial expressions which reflect the association of a *fluency error signal* with the child's utterances, the child's speech *automaticity*[4] may conceivably begin to deteriorate. This spurious *fluency error signal* could theoretically hold a *control point* until an attempt had been made at some type of intentional[5] feedback monitoring by the *system* and this irregular scanning of the *articulatory cycle* for

[4]In this instance, the product of predicted *fluency zero error signals* within the *comparator* which, in turn, allow *control points* in the *governor* to flow rapidly without feedback monitoring.

[5]As opposed to the nonintentional or subconscious self-reflexive monitoring that all intact oral language mechanisms are continually engaged in.

nonexistent *error signals* may eventually reflect itself in stuttering speech. Furthermore, if the undeveloped *system* is exposed frequently to this *open cycle fluency error signal*, internalization may occur, and the *system* may, consequently, develop a *closed cycle fluency error signal. Deautomaticity* is then amplified from a comparatively simple type to an elaborate type.

Relative to *system readjustment*, if the *fluency error signal* is still on an *open cycle* basis, it is theoretically possible to resolve the situation by dealing only with the source of the inappropriate *signals*, which is essentially what Johnson advocates. However, if the *open cycle fluency error signal* has been internalized and is now part of the *closed cycle system*, direct *readjustment* of the child's *system* is indicated and involves the progressive weakening of both *closed* and *open cycle fluency error signals.*

With reference to this latter involvement, Johnson once outlined the steps of an approach which consisted of (a) making the individual aware of his ability to speak with normal fluency by choral reading, singing, impersonating, rhythmic speech, *etc.*, (b) 'streamlining' the individual's excessive nonfluency by employing bounce or prolongation techniques, (c) developing the individual's tolerance for normal nonfluency and, finally and most importantly, (d) developing a high degree of consciousness of the individual's own self-reflexive abstract process which perpetuates the problem. The last aspect consists of becoming conscious of the internalized parental high standards of fluency which cause a reaction within the individual to his own normal nonfluency, resulting in verbal and nonverbal tensions which then excite reactions within the individual to these reactions.

In terms of *servotherapy*, Johnson's approach basically involves (a) reducing the *deautomatizing* effects of the internalized *open cycle fluency error signal* by having the *system* transmit acoustic symbols which ordinarily have not been associated with such an *error signal*, *e.g.*, singing, choral speaking, *etc.*, and (b) further weakening the *signal* by using the *system accommodation* technique of intentionally producing an *error-* associated *output*. (There is also a reduction in verbal and nonverbal tensions, or *system stresses*, when simpler forms of *deautomaticity* such as bouncing or prolongation are used instead of more complicated types.) As the internalized *open cycle fluency error signal* is progressively weakened by this process and the *communication system* is *primed* to verbalize about the procedure, the *system* eventually drops the *signal* and *automaticity* is re-established.

Sheehan's Conflict Theory. According to Sheehan (*3*), the double approach-avoidance conflict is the essence of the stuttering problem. For the stutterer, then, both speech and silence have positive and negative valences. Sheehan says, 'Since guilt conspicuously produces blocking in the speech of young children and guilt is an important dynamic in the advanced stutterer, it is likely that guilt feelings lie heavily in the background of the onset of stuttering.' Unexpressed hostility, verbal aggression, *etc.*, are also considered factors in stuttering behavior. The stutterer has a communication goal but also a fear arising from several possible

sources or levels of conflict. Five such levels have been described by Sheehan: word level, situation level, emotion loading of speech level, inter-personal relationship level and the ego-protective level.

In general, this type of orientation appears related to *deautomaticity* of the *integrator unit circuit, i.e.*, a break in the reflex and automatic relationship between the concept and motor speech mechanisms, or between the *storage* and *governor* components. Descriptively, this means that when certain ganglionic equivalents of concepts are excited within the *system* as a result of exposure to particular *open cycle* stimulation and if these are of a disturbing nature (guilt feelings, oral aggression, *etc.*), they may result in *system oscillation* tendencies relative to speech or silence. Consequently, the *system* does not 'present,' in an integrated manner, the concept to the motor speech mechanism.

The general goal of rehabilitation for stuttering as expressed by Sheehan is the reduction of all tendencies to avoidance and of the fears which motivate them; toward this end special speech and psychotherapeutic techniques are applied.

Broadly and simply, in terms of *servotherapy*, efforts are made at progressively weakening the *noise* in the feedback *circuits* of the *integrator unit*. That is, since *open cycle* stimulation of particular ganglionic equivalents of concepts results in exciting *system noise* between concept and word mechanisms, procedures should be directed at *priming* the *system* (a) to discover and analyze the disturbing *open cycle* influences and to internalize this information and (b) to continue to reduce *noise* either by adopting new ganglionic concept equivalents in response to disturbing stimulation or by lessening the adverse reactions by virtue of *system accommodation*, or desensitization techniques.

West's Ictocongenital Hypothesis. Recently West (*3*) has conjectured that stuttering is primarily an epileptic disorder which manifests itself in dyssynergies of the neuromotor mechanism for oral language and that these spasms are precipitated by social anxieties involved in communication by oral language. West states that the fundamental disorder may very well be related to pyknolepsy[6] and may be referred to as 'phemolepsy,' or 'speech epilepsy,' and like pyknolepsy should cease at about the time of puberty; however, the developed psychoneurotic aspect of the problem causes the disorder to be perpetuated.

West's hypothesis might very well be connected to *deautomaticity* resulting from actual interference in the automatic mechanism between the *governor* and the *mixer-effector* components. The psychoneurotic aspect expressed by West involves inefficient attempts at *system self-readjustment* after a justifiable *fluency error signal* is eventually developed as a conse-

[6]West states that medical chapters on epilepsy contain a section on pyknoepilepsy, or pyknolepsy, and that the disorder is chiefly confined to those very muscles that are first involved in childhood stuttering. 'Its onset is between the ages of four and 10; convulsions occur often, sometimes as many as 100 per day; they are of such momentary duration that apparently they are not accompanied by loss of consciousness or preceded by aurae; the symptoms usually disappear in a few years, leaving the intelligence unimpaired.'

quence of the disruption of the *system's* automatic discharge of *control points*.

In essence, therapy as outlined by West, whether it be for simple or elaborated *deautomaticity*, is basically concerned with minimizing the psychosocial trigger points that result in lowering the susceptible individual's thresholds for convulsive episodes of the neuromotor mechanism for oral language.

West's concept, as compared to the other theories discussed, implies that there is *system noise* due to actual nerve tissue involvement resulting from an epileptiform disorder. The break, therefore, in *verbalizing automaticity* between the *governor* and the *mixer-effector units* is associated with periodic uncontrolled discharges of electrical potentials. However, West suggests that if the *system* would not attempt *self-adjustment*, which is usually motivated by *open cycle* influence, the problem should eventually resolve itself at about puberty. In this instance, *servotherapy* during the simple *deautomaticity* or actual organic spasm stage, would consider the use of *circuit regulators* or tranquilizers. The use of medication in this type of problem might be expected to be of greater value than when used with adult stutterers in general *(6)*. It would be hoped that the use of *circuit regulators* in this situation would serve as a prophylactic against the development of elaborated *deautomaticity*.

Theoretical Reflections. On the basis of additional inferences resulting from the above discussion, the hypothesis is reiterated that efficient oral language *input-output* depends on series of *noise-free open* and *closed cycle circuits* of reflexive and automatic mechanisms. Retrospection reveals that two *open* and two *closed cycle automaticity* disturbances were described, and it is conjectured that future investigations may discover varieties of stutter configurations which may bear some kind of relationship to the locus of *circuit* involvement. Furthermore, relative to the theorists discussed, it is felt that each man, rather than attempting to describe one type of disorder in three ways, may actually be describing three types of *deautomaticity* in one way.

Servotherapy Approach

As a function of the ideas of the present and previous *(8)* papers and as an initiatory effort in attempting to develop a supportable stuttering clinical approach based on these hypotheses, the following general preliminary principles are offered:

Analysis for Type of Verbalizing Deautomaticity. For a more specific and effective regimen, the clinician should first attempt to discover what part of the cliniciate's *system* is primarily responsible for the break in automatic speech. This might be done by (a) careful examination of the complete etiological history of the individual, (b) interview sessions and (c) eventual recognition of stutter patterns. The value of this initial step may be appreciated if, *e.g.*, the clinician feels he is dealing with a *controller unit* problem of the West variety and might, therefore, desire medical assistance in the form of supervision of drug administration, or if he feels he is confronted with primarily an *open cycle*

problem and chooses to work with the *open cycle* influences alone.

Weakening Open Cycle Fluency Error Signal. Procedures to minimize the disrupting effects on the cliniciate's *system* by outside *systems* are planned; in the case of simple *deautomaticity* efforts may be exclusively directed at the offending *systems* in the environment. In cases of elaborated *deautomaticity*, the cliniciate's *system* should first be informed of the purpose of this step of weakening adverse *open cycle* influences; then procedures such as Van Riper *(12)* has outlined under the headings of desensitization, nonreinforcement, ego-building and self-understanding should be considered. Consequently, if the *deautomaticity* is strictly on the *integrator unit* level, concentration on the above goals should, theoretically speaking, be most important.

Amplifying Closed Cycle Fluency Zero Error Signal. Instead of the cliniciate's externalization of his problem in the form of repetitions, hesitations, *etc.*, or his indulging in the overt inefficient reduction of an anticipated *fluency error signal* by intentional auditory and tactile-proprioceptive monitoring (depending on the individual *system*, one or combinations of the three are employed), it is proposed that the cliniciate should weaken the disturbing *signal* and, consequently, amplify the desired *zero error signal* by monitoring on the *integrator unit* level, *i.e.*, engage in *verbalizing imagery* monitoring similar to the procedure recently outlined by Bluemel *(2)*. The facilitation of the development of integrated ganglionic equivalents of projected motor speech units by this *verbalizing imagery* monitoring should assist in amplifying the desired *signal*. Bluemel's phantom speech (talking with light lip and tongue movements, but without sound) and whispering speech techniques might also be of assistance here; these latter steps are aimed at weakening the disintegrating *signal* by monitoring on tactile-proprioceptive channels rather than on the more usual auditory channel. Techniques outlined by Van Riper *(12)* under the headings of voluntary control and fluent stuttering might also be applied here.

Monitor Channel Switching. If it should be discovered that auditory anomalies or sensitivities are simulating situations associated with experimentally produced delays in auditory sidetone, efforts could be directed at developing another *sensor* channel as the chief monitoring system. For example, in cases where phantom or whispered speech eventually helps a *system* to *readjust*, it may be due to the complete or incomplete transference of the major speech monitoring function to the tactile or proprioceptive channel and away from the offending auditory circuit. Accordingly, some individuals have been known not to react to auditory delay with stuttering behavior and it has been inferred that these individuals are capable of monitoring with other than the auditory channel.

Further development of these hypotheses will be forthcoming upon more clinical application and research. It should be noted that some of these ideas have been applied to stuttering in one form or another by various clinicians but without adequate explanations of why they were effective.

It is hoped that by virtue of a servo theory orientation a systematic and theoretically supportable clinical approach will evolve.

Summary

From the standpoint of the oral language mechanism as an *open* and *closed cycle* servosystem, stuttering was viewed as a condition of *verbalizing deautomaticity*. *Deautomaticity* was seen as the possible result of disturbances in reflexive and automatic mechanisms in various parts of the *total linguistic circuitry*. Some of these concepts were related to the ideas of different authorities in the field of stuttering theory. The paper concluded with a brief description of a few preliminary techniques based on principles of servo theory.

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CLINICAL FORUM

Esther L. Herbert, Editor

• Clinical Observations Regarding Negative Practice

The use of negative practice for eliminating incorrect speech sounds is well known. The youngster with a speech problem is taught to practice the incorrect sound. According to the original Dunlap formulation, such negative practising will make the act conscious and subject it to extinction.

In working with a large number of preadolescent boys, the technique of negative practice has not proved wholly satisfactory. Some consistent and recurring observations of these boys have been made:

1. Many of the boys associated the incorrect sound with doing something bad. One boy said, 'That's the worst thing you can do. My mother would kill me if I said the sound worse at home.' Other boys expressed the feeling that it was 'kind of sneaky' or 'wrong and bad' to practice incorrect sounds.

2. Negative practice also caused guilt feelings. It was not simply that the boys felt embarrassment, but also that they had feelings deeply rooted in guilt. In a very real sense, they were doing something naughty. Because the act itself had been disapproved of by the family, they felt guilty in performing it.

3. Negative practice when offered as a remedial technique created intense conflict in the boys. On the one hand, they wished to be cured and viewed the technique as a magical act which would change their speech. On the other hand, the guilt they felt about performing the forbidden act brought about inner conflict. One boy reported a dream in which he was on a raft floating down a rapid stream. On opposite banks were individuals pulling him in different directions.

Many of the boys openly expressed their feelings about kicking up a storm at home or creating quite a stir in class with the loud lisping sound. Some of the boys were of the type who never get into trouble and who usually do the right thing, boys who were externally well-disciplined. For them, negative practice was viewed as an opportunity for retaliating, for asserting themselves, even for expressing hostility. Conflicts arose when they worried about how others might react or what their mothers would say. Many were torn between what they wished to do and what they fantasied would occur if they did act freely.

4. The act of 'lisping' had a specific symbolic value for many of the parents and the children as well. Mothers stated that the sound seemed to them a sissy sound, or one characteristic of effeminate boys. Some of the mothers viewed the lisp as evidence that their sons were not manly. These mothers tended to reject the negative practice because it

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stirred up fears they were trying to control or avoid.

Strength of the parental fears about their son's masculinity could be gauged frequently by the degree to which the parents rejected the use of negative practice. Parents who refused to allow their children to practice the *s*-sound incorrectly also expressed the strongest feelings about their boy's sissy attitudes. This attitude was sometimes expressed as concern that the boy was not doing well in sports or that he was playing with an effeminate child.

As parents began to describe their feelings and to talk out their problems regarding negative practice as a clinical technique, the intensity of their reactions diminished. Some gained sufficient insight in a few counselling sessions to keep a check on their reactions. Others needed more intensive help which was unavailable to them. As might be expected, some parents were so guarded concerning their own problems and feelings that it was not possible to do any counselling with them.

In those cases in which parents were able to work through some of their feelings and the children were also able to come to some understanding of their problem, negative practice became a potent tool in the treatment program. In other instances, where neither child nor parent could work out the problems, a change in technique was made. In a few cases the youngster was able to resolve some of the conflict and use negative practice with discretion, rather than as a weapon.

It is important that clinicians consider the psychological forces which are generated and remain active within a child when he is urged to use a technique such as negative practice. The technique may simply reawaken old problems which must be dealt with effectively before the technique itself can become a vital part of the therapeutic program.

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• A Case of Involuntary Vocalization

A 14-year-old male with involuntary vocalization was recently seen for clinical diagnosis. His apparently rare problem had unusual manifestations. While the patient was listening to the examiner, vocalizations were emitted by the patient which were noncommunicative. They consisted for the most part of glottal sounds and single syllables and consonants such as [s], [k] and [uh]. Grunts were also produced. Occasionally the involuntary vocalizations intruded even in spontaneous conversation. Facial tics were also present. The patient was of normal mentality.

Because of the possibility that the facial and vocal tics may have been emotionally based, the boy had been seen for psychiatric treatment prior to being brought to the speech clinic. Psychiatry had failed to reduce or eliminate the tics. According to the mother's statement, the medical specialists she has consulted recently now feel that etiology might reside in suspected encephalitis in infancy and is neurologically based.

Communications from those having had experience with similar cases would be welcomed.

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ABSTRACTS

Phillip A. Yantis, Editor

NOTE: I have been asked by the Editor to announce that with the formal activation of the National Index on Deafness, Speech and Hearing, the Committee on Publications has decided to discontinue the publication of abstracts in the *Journal of Speech and Hearing Disorders.* Henceforth, all abstracting activities in the three major fields of interest to members of the American Speech and Hearing Association will become the responsibility of NIDSH.

The National Index on Deafness, Speech and Hearing is a joint venture of Gallaudet College and ASHA, with the assistance of the Office of Vocational Rehabilitation. One of the functions of NIDSH will be the quarterly publication of an abstracts journal extensively covering the world's literature in the three areas of interest. The first of these publications should appear in the fall of this year and will be composed of abstracts of articles published after January 1, 1960. It is anticipated that each member of the Association will receive a complimentary copy of the first issue. The greater comprehensiveness in abstracting and indexing functions that can best be implemented by such an organization should serve a great need to members of our profession, as well as to many others. Further information on the National Index may be obtained by writing the Director, Dr. Stephen P. Quigley, Gallaudet College, Seventh St. and Florida Avenue, N.E., Washington 2, D.C.

On behalf of the Editorial Staff of the *Journal of Speech and Hearing Disorders,* I wish to thank all of the members of the Abstracts Committee, both present and past, for their tireless contributions to this department. It has only been through their patient diligence and professional acumen that we have been able to bring this service to the readers of the *Journal.*

—P. A. YANTIS

Phillip A. Yantis (Ph.D., University of Michigan, 1955) is Instructor and Audiologist, Department of Otolaryngology, University of Michigan School of Medicine. Those who assisted in the preparation of abstracts for this issue were: Robert W. Albright, Arizona State College; Robert Bilger, University of Michigan; Emil Froeschels, New York City; Janet Jeffers, Los Angeles State College; Bernard A. Landes, Texas Technological College; Dominic A. LaRusso, University of Washington; Boris V. Morkovin, University of Southern California; Max Nelson, Michigan State University; E. Harris Nober, Adelphi College; Herbert J. Oyer, Ohio State University; Bernard B. Schlanger, West Virginia University; and Barbara S. Street, Minneapolis.

Anatomy and Physiology

ANTHONY, A., ACKERMAN, E., and LLOYD, J. A., Noise stress in laboratory rodents. I. Behavioral and endocrine response of mice, rats, and guinea pigs. *J. acoust. Soc. Amer.,* 31, 1959, 1430-1437.

'Mice, rats, and guinea pigs were exposed daily to high intensity noise in the frequency range of 150-4800 cps at a sound pressure level of about 140 db, *re* 0.0002 •bar. It was found that the behavioral and endocrine responses differ in the three species studied. The adrenal responses of animals exposed to noise supports the interpretation that noise acts as a physiological stress, but does not induce harmful extra-auditory effects. Thus, the endocrine system appears to act as a multiloop feedback system which compensates for the effects of noise on the central nervous system.' *(Authors' precis)*

ANTHONY, A., and HARCLERODE, J. E., Noise stress in laboratory rodents, II. Effects of chronic noise exposure on sexual performance and reproductive function of guinea pigs. *J. acoust. Soc. Amer.,* 31, 1959, 1437-1440.

'Chronic exposure of male guinea pigs to intense, low-frequency noise (139-144 db, 300-4800 cps) for six weeks did not affect their sexual performance. Histological and histochemical analyses of various organs indicated noise is followed by increased activity of the adrenal glands. However, the absence of pathology in the reproductive and digestive

organs indicated that the tolerance limits of animals were not exceeded.' *(Authors' precis)*

GALAMBOS, R., SCHWARTZKOFF, J., and RUPERT, A., Microelectrode studies of superior olivary nuclei. *Amer. J. Physiol.*, 197, 1959, 527-536.

Microelectrode studies of the superior olivary complex of anesthetized cats indicate that (1) the different segments of the superior olivary complex are differently innervated from the two ears; (2) most units displayed a best frequency in response to tones; (3) a higher intensity of sound increased activity within a unit and also brought other units into action; and (4) the fact that some units always responded to the first of a pair of binaural clicks, regardless of which ear was stimulated first, thus preserving arrival time at the cochlea, suggests a mechanism of binaural localization. *(R. C. B.)*

LEGOUIX, J. P., and TARAB, S., Experimental study of bone conduction in ears with mechanical impairment of the ossicles. *J. acoust. Soc. Amer.*, 31, 1959, 1453-1457.

Using guinea pigs in which the ossicles were impaired mechanically in various ways, cochlear microphonics were measured during bone-conducted sound. Significant among the findings was the effect on phase as a result of mechanical obstruction. In some cases this phase shift was forward, thus explaining the Weber phenomenon. *(B. A. L.)*

PENNETTA, G., and PINTO, F., Le teorie dell'udito alla luce delle recenti acquisizioni di fisiologia. (The theories of hearing in light of recent acquisitions in physiology.) *Riv. Audiol. Prat.*, 8, 1958, 79-101, 103-133.

In a series of articles, the authors examine various theories of hearing in light of recent experimentation in physiology. The theories are grouped into resonance theories (Helmholtz, Ewald, *etc.*), frequency theories (Rutherford, Ayers, *etc.*), hydodynamic theories (Ranke, Hurst, *etc.*), and modern theories (Wever, Hilding, *etc.*). The authors conclude that many older theories must be modified to fit present day results of experimentation. *(D. A. L.)*

SIMMONS, F. B., GALAMBOS, R., and RUPERT, A., Conditioned responses of middle ear muscles. *Amer. J. Physiol.*, 197, 1959, 537-538.

'Simple and differential conditioned response of middle ear muscle to visual stimuli were produced in awake cats with electrodes implanted chronically on the round window. Muscle contractions were observed indirectly through their effects on the cochlear microphonic. These CRS are easily produced and have very short latencies (80 msec) under optimal conditions. Somewhat longer minimal latencies (150 msec) were measured in the differential learning situation. The stapedius was shown to play the dominant role in those conditioning experiments where only one of the two middle ear muscles was left intact.' *(Authors' precis)*

STROTHER, W. F., The electrical response of the auditory mechanism in the bullfrog. *J. comp. physiol. Psychol.*, 52, 1959, 157-162.

The hearing acuity of the bullfrog was studied intensively by means of electrical potentials. Results indicate, for example, poor loudness discrimination and frequency sensitivity in approximately the 3-3000 cps range. *(B. A. L.)*

TONNDORF, J., The transfer of energy across the cochlea. *Acta otolaryng., Stockh.*, 50, 1959, 171-184.

On the basis of observations of a cochlear model, the author attempts to resolve the conflict between the *pressure-wave* and the *traveling-wave* concepts. *(R. C. B.)*

General

HARPER, P. A., FISCHER, L. K., and RIDER, R. V., Neurological and intellectual status of prematures at three to five years of age. *J. Pediatrics*, 55, 1959, 679-690.

Four hundred sixty prematurely born children examined at three to five years of age were matched with controls to ascertain the extent to which surviving prematurely born infants differed from full-term infants in subsequent development. The results indicated that the prematurely born group was somewhat lower in intellectual status and to have a smaller proportion classed as neurologically normal than the full-term children. On subdividing the prematures by birth weight, the trend favored those with larger birth weights. The authors emphasize that the great majority of those infants born prematurely fall within the normal range and their distribution of intelligence ratings closely approximate those born at term although somewhat on the lower side. *(B. B. S.)*

KODMAN, F., SEDLACEK, G., and POWERS, T., A preliminary study of the personality characteristics of auditory malingerers. *Acta otolarnyng., Stockh.*, 50, 1959, 455-462.

Persons who malinger with respect to audi-

tory hearing loss are reported to have strong neurotic tendencies and a greater number of psychosomatic complaints than nonmalingerers in terms of *t* scores from the MMPI. *(R. C. B.)*

LUPER, H. L., Relative severity of stuttering ratings from visual and auditory presentations of the same speech samples. *South. Speech J.*, 25, 1959, 107-114.

Judges' ratings of visual samples of stuttering, on film, were generally higher than their ratings of the same samples presented on tape. *(B. A. L.)*

REYNIER, J. P. DE, HUIZING, H. D., and NAUMANN, H. H. VON, FORTSCHRITTE DER HALS-NASEN-OHRENHEILKUNDE. *Progrès en Oto-rhino-laryngologie. (Advances in Oto-Rhino-Laryngology.)* Edited by L. Rüedi. Basel and New York: S. Karger, 1959. Pp. 176. $6.90.

This book consists of three articles, two on deaf-mutism and one on the absorption of foreign substances in the nasal mucosa. Since the article on absorption deals more with physiological chemistry than speech, it will not be included in this abstract.

The first article, 'La surdi-mutité en Suisse en 1953,' (Deaf-Mutism in Switzerland in 1953), pp. 1-73, is a report by J. P. De Reynier on a census of deaf-mutes. The questionnaire which he used covers three aspects of the individual: personal situation (name, first language, *etc.*), hearing disability (age of onset, speech before deafness, diseases, *etc.*), and educational and occupational history. The results show 4,573 deaf-mutes in Switzerland's total population of 4,870,000 in 1953, or about 113 per 100,000 allowing for 1000 deaf-mutes that may not have been counted. As in the rest of Europe, there has been a decrease in deaf-mutism in Switzerland.

The use of iodized salt since 1922 and decrease in consanguineous and heterozygous marriages have reduced congenital deaf-mutism, while progress in otology and general medicine has reduced the frequency of the acquired type.

Age distribution shows a low incidence of deaf-mutism between 0-27 years and a higher incidence between 30 and 70 years, with a high peak between 30 and 59 years. Few cases were recorded between 0-4 years, which is partly due to present inadequacies in discovering deaf-mutism in children.

Sex distribution shows a higher incidence for men than women, 52 and 48 per cent, respectively, which is the reverse of the general population ratio of approximately 52 per cent women and 48 per cent men. This predominance of male deaf-mutism is also found in other countries.

Two general needs in helping those with deaf-mutism are (1) the need for using modern methods such as the peep-show and psychogalvanic tests in discovering the disorder, and (2) the need for more enlightened attitudes toward the marriage of deaf-mutes. The old idea that they should not marry in order to avoid transmission of the defect is reflected in a lack of increase in their marriage rate. Marital advice in such instances needs to be based upon genetic data and careful auditory examination.

The second article, 'Deaf-Mutism: Modern Trends in Treatment and Prevention,' pp. 74-106, written in English by H. C. Huizing, outlines the evolution of deaf-mute education. He sketches the nineteenth century division between the oral (German) and manual (French) systems, and credits Urbantschitsch with introducing hearing exercises as a substantial part of the training of the deaf around the turn of the century. The current phase in the evolution of the education of the deaf might be termed 'educational audiology,' according to the author.

The author emphasizes the importance of the spontaneous development of communicative ability in an auditory-linguistic society. In describing the growth of language, he distinguishes five levels of development: (1) a primary level characterized by auditory discrimination and spatial awareness; (2) a vocal level in which vocalizations develop into a 'hearing controlled voice' around eight to nine months with perception of an inner and outer auditory world; (3) a symbolic level with developing speech-sound discrimination, and concrete and abstract concepts; (4) an oral level with more use of expressive language as well as comprehension; and (5) a final level of syntax.

Huizing's scheme of education for the deaf includes home training, special day classes, and general education. Audiologic education requires group treatment to 'infuse' the child into communication, as well as individual treatment. He regards the following as needing more stress at present: (1) development of home training programs for preschool deaf children, (2) the investigation of methods of grouping children for classroom instruction, and (3) the improvement of acoustic conditions in classrooms. *(R. W. A.)*

RHEINGOLD, H. L., GEWIRTZ, J. L., and ROSS, H. W., Social conditioning of vocalizations

in the infant. *J. comp. physiol. Psychol.*, 52, 1959, 68-73.

Using 21 normal three-month-old infants as subjects, responses to an 'expressionless face' were compared with responses to stimulation in the form of 'simultaneously smiling, clucking, and touching S's abdomen.' Results suggest that social responsiveness of infants may be modified by the response of the adult. *(B. A. L.)*

SCHAFFER, H. R., and CALLENDER, W. M., Psychologic effects of hospitalization in infancy. *Pediatrics*, 24, 1959, 528-539.

Seventy-six infants less than 12 months of age were observed while undergoing short-term hospitalization. Two main syndromes emerged, each linked to a certain age range with a dividing point at approximately seven months. Infants above seven months were considerably upset, demonstrating the need for the physical presence of the mother. Infants below seven months seemed to adjust immediately to the new environment and the people in it. The authors suggest that the critical period when separation from mother is experienced as a traumatic event does not commence until after the middle of the first year of life. *(B. B. S.)*

SIEKERT, R. G., BROWN, J. R., AIGNER, B. R., KEITH, H. M., and DION, F. R., Symposium on ataxia in childhood. *Proc. staff Meetings Mayo Clin.*, 34, 1959, 569-590.

Four articles on the general subject of ataxia in childhood are prefaced by a short introduction. The first of these articles deals with the physical signs of ataxia and the technique of examination in children of various ages. The second refers to the differential diagnosis of acute ataxia in children, including a description of such clinical entities as acute cerebellar ataxia, peripheral neuritis and neuronitis, multiple sclerosis, intoxication, cerebellar tumors, brain-stem tumors, spinal-cord tumors, ataxia due to hysteria, and Hart's syndrome. Seven illustrative cases are presented. The third article describes the syndrome of ataxia-telangiectasia in children, with a report of three cases. The subject of persistent ataxia in children is discussed in the last paper. *(P. A. Y.)*

THOMPSON, R. F., The effect of training procedure upon auditory frequency discrimination in the cat. *J. comp. physiol. Psychol.*, 52, 1959, 186-190.

'Cats were trained under three procedures in frequency discrimination. The *repetitive* procedure involved response to only one change, an alternation between 1000 cycles and 1500 cycles, from a background stimulation of a repeated 1000-cycle tone. In the *alternation* procedure, animals were required to respond to four cycles of alternation of the two tones, but not to respond to eight presentations of the 1000-cycle tone. In the *absolute* procedure, they were required to respond to one presentation of a 1000-cycle tone but not to a 1500-cycle tone. The repetitive group learned faster with better thresholds than did the alternation group. The absolute group could not learn the discrimination.' *(Author's summary)*

WINITZ, H., Language skills of male and female kindergarten children. *J. Speech Hearing Res.*, 2, 1959, 377-386.

A study of 150 five-year-old children reveals no significant difference in language and articulation skills between males and females in terms of most items tested. *(B. A. L.)*

Pathology

AKELAITITE, A. V., K voprosu o geneze morfologicheskikh izmenenii vnutrennego ukha pri deistvii akustisheskoi travmy. (Experimental research: the problem of genesis of morphological changes of the internal ear under the effect of acoustic trauma.) *Vestnik O. R. L., Moskva*, 20, 1958, 59-64.

In order to elucidate the role of the central nervous system in the genesis of pathological changes of the internal ear due to acoustic trauma, the author carried out experiments on white rats subjected to intensive sound (4000 cps). Prior to that the cortex of the temporal and parietal lobes of the brain had been removed in some of the animals. Quite soon dystrophic changes in the nervous apparatus of the cochlea developed in these animals, whereas in animals who did not undergo the operation the above changes appeared at a later stage. The author sets forth his opinion that the cortex of the brain exerts a protective influence on the receptor apparatus of the cochlea in acoustic trauma. *(B. V. M.)*

BROCKMAN, S. J., An exploratory investigation of delayed progressive neural hypacusis in children. *Arch. Otolaryng., Chicago*, 70, 1959, 340-357.

Serial audiograms of 13 children with a delayed form of neural hypacusis are analyzed for possible similarity and progression of loss. The author found a progressive deterioration in the average level of hearing in

the 500 to 2000 cps range, from four to seven years of age followed by a latency of several years and then a steady deterioration to a 60 to 70 db level. Losses in the speech frequencies increased in a fairly flat distribution. The author believes there is a possibility that heredity may be an important etiological factor. *(J. J.)*

CHAIKLIN, J. B., VENTRY, I. M., BARRETT, L. S., and SKALBECK, G. A., Pure-tone threshold patterns observed in functional hearing loss. *Laryngoscope*, 69, 1959, 1165-1180.

A series of audiograms and case histories are presented of individuals with a functional overlay as revealed by GSR testing. The authors found the 'saucer-type' audiogram to be characteristic of only seven out of 190 ears. There does not appear to be a single pure-tone threshold configuration characteristic of functional hearing loss. Functional overlay was limited in magnitude at frequencies where the ears recruited. *(J. J.)*

FISCH, L., Deafness as part of an hereditary syndrome. *J. Laryng.*, 83, 1959, 355-382.

An hereditary syndrome that includes deafness as its major symptom is described. In addition to deafness this syndrome includes (1) malformation of the inner angle of the eyelids, (2) heterochromia iridium, and (3) a white forelock. The differential diagnosis of this syndrome is discussed and histological studies of the cochlea of a child with this syndrome are presented. *(R. C. B.)*

HINCHCLIFFE, R., The threshold of hearing as a function of age. *Acustica, Stuttgart*, 9, 1959, 303-308.

'The threshold of hearing has been measured at frequencies ranging from 125 to 12000 c/s on a random sample, stratified for age and sex, that had been drawn from a representative rural population in Great Britain. Clinically abnormal ears were discarded from the analysis. For all age groups, there was a significant difference between the thresholds for the two sexes at three, four, and six kc/s. For the older age groups, there was also a significant sex difference at two and eight kc/s. This sex difference is most probably attributable to acoustic trauma. The curves showing threshold of hearing as a function of age that are presented for clinically normal female ears may be considered as pure presbycusis curves.' *(Author's precis)*

HINCHCLIFFE, R., The threshold of hearing of a random sample rural population. *Acta otolaryng., Stockh.*, 50, 1959, 411-422.

The auditory sensitivity of 50 males and 50 females in the 18-24 year age group from two different rural areas was measured with a clinical audiometer. The less sensitive thresholds for middle frequencies (three to six kc) obtained from the men in the sample were explained in terms of trauma resulting from small-arms fire. *(R. C. B.)*

INGRAM, T. T. S., Specific developmental disorders of speech in childhood. *Brain*, 82, 1959, 450-467.

The histories, speech defects, and clinical findings of 80 children with retarded development of articulation were studied at the Speech Clinic of the Royal Hospital for Sick Children, Edinburgh. Fifty-eight were boys, and 22 were girls; 55 were under five years of age.

It was found that a high proportion of patients had a family history of similar speech defects. High proportions of patients had retarded speech development, language disabilities and impairment of understanding spoken language. A higher proportion showed little lateralization of handedness and footedness than a control series. School-age patients frequently showed developmental dyslexia and dysgraphia. The articulation defects could not be attributed to mental impairment, hearing loss or abnormalities of the speech mechanism. They may be regarded as one of the manifestations of the 'developmental speech disorder syndrome' which includes retardation of speech development, language disorders, comprehension difficulties, and specific dyslexia and dysgraphia. *(B. S. S.)*

KOMAROVICH, G. M., Vlianie fenestratsii na slukh i vestibuliarnuiu funktsiu u eksperimentalnykh zhivotnykh. (The influence of fenestration on hearing acuity and on vestibular functions in experimental animals.) *Vestnik O. R. L., Moskva*, 20, 1958, 23-28.

A number of experiments have been carried out on guinea pigs in order to elucidate the following: (1) the course of reparative processes following an isolated surgical incision of the semicircular canal and (2) how the latter affects the hearing acuity and the vestibular function. Histological control and objective methods of functional study with registration of biocurrents of the cochlea were applied. *(B. V. M.)*

LANDES, B. A., On the clinical nature of spastic dysphonia. *South. Speech J.* 25, 1959, 141-144.

The symptomatology observed in spastic dysphonia is presented in the form of two case histories with the thesis repeated that this disorder of voice may be part of the larger syndrome of stuttering. *(B. A. L.)*

LAW, F. E., and FULTON, J. T., Unoperated oral clefts at maturation. *Amer. J. publ. Hlth*, 49, 1959, 1517-1524.

The objective of this study was to determine the facial and nasopharyngeal growth and development of 124 native Puerto Ricans between the ages of 15 and 57. Their speech, voice, hearing, medical history and social status were studied. The subjects collectively represented a wide variety of lip and palate clefts. Some had no prior surgery, others had partial surgery, and a few cases were completely repaired. Sex was evenly divided. The repaired and partially repaired group served as a control for the unrepaired group.

The health and physical functioning of the unrepaired group seemed equal to the repaired group. Facial growth and development achieved near normal skeletal dimensions in the unoperated group. Velopharyngeal tissues, in this group, gave evidence of atrophy, which was probably related to malfunction. The tongue movements, in the unrepaired group, were carried out at a much higher position in the oral-nasal cavity. In repaired clefts, tongue positioning simulated the normal. Some individuals with complete unrepaired clefts (from lip to soft palate) appeared near normal in voice quality, which was probably due to having only one resonating cavity. Two-thirds of the unoperated group had normal hearing. *(E. H. N.)*

LAWRENCE, M., and MCCABE, B., Inner-ear mechanics and deafness. *J. Amer. med. Ass.*, 121, 1959, 1927-1932.

The inner-ear changes of a woman who suffered from Ménière's syndrome for four years were studied after she died from other causes. There was evidence that the cochlear duct ruptured from overdistension due to an excess of endolymph and this was followed by partial repair. The ideal solution to relieve the symptoms is to find the cause of, and to prevent the production of, excessive endolymph. Another remedy is destruction of the cochlea rather than destructive labrinthotomy. The former produces deafness but relieves the vertigo, which is the more disabling of the two symptoms. *(E. H. N.)*

LEGOUIX, J. P., Étude expérimentale du mécanisme de la conduction osseuse dans les cas des surdité de transmission. (Experimental study of the bone-conduction mechanism in conduction deafness.) *Ann. Oto-laryng.*, 76, 1959, 930-936.

An experimental study was made of the effects upon the cochlear microphonic in guinea pigs of immobilizing the ossicular chain, increasing its mass, and removing it, and of the effect of pressure changes in the bulla tympani. Results indicate two components in transmission. One is due to the inertia of the ossicular chain, and the other to that of the cochlear structures. Immobilization of the ossicles, as well as increasing pressure within the bulla, produces an advance in phase of vibration in the affected ear which may explain lateralization on the Weber test. *(R. W. A.)*

LURIA, A. R., Disorders of 'simultaneous perception' in a case of bilateral occipital-parietal brain injury. *Brain*, 82, 1959, 437-449.

A case is described in which marked derangements of visual perception and orientation occurred as sequelae of a bilateral occipito-parietal brain injury. Restriction of visual perception to a single object or configuration was noted. This deficit can best be explained by Pavlov's theory of cortical activity which postulates there is a general functional weakness or reduction of cortical tonus of the affected portions of the brain. In consequence each focus of excitation within this area inhibits the remainder of the visual cortex by way of negative induction. If a large number of stimuli are simultaneously presented, only a very few are likely to elicit a perceptual response, causing the patient to perceive only a restricted element or aspect of the total stimulus pattern. The author feels it is probable that an explanation of this kind will cover many of the phenomena of visual agnosia described in the literature, but more adequate understanding of these syndromes in terms of changes at the neurological level remain for future research. *(B. S. S.)*

MABRY, C. C., Prolonged neonatal anoxia without apparent adverse sequelae. *J. Pediatrics*, 55, 1959, 211-215.

The author reports on a prematurely born infant who survived anoxia for at least 15 and probably 30 minutes. At the age of 20 months no harmful sequelae have been observed. The author suggests that observation and testing at a later stage in development may demonstrate the anoxic effect. *(B. B. S.)*

MIANI, P., Studio sperimentale sulle modificazioni della coclea indotte da occlusione

del condotto auditovio esterno. (An experimental study of cochlear modifications induced by an occlusion of the external auditory meatus.) *Oto-rino-laryng. ital.*, 26, 1958, 129-142.

The author, reporting the results of his work on guinea pigs, describes the nature of structural changes produced in the cochlea of a guinea pig by an artificial occlusion of the external auditory meatus. He notes that, as a result of forced disuse, the cochlear tissue manifests neurological and circulatory degeneration. *(D. A. L.)*

Motta, G., Ceroni, T., Barbara, L., and Fuzzi, M., Le sordità cocleari negli epatopazienti. (Cochlear deafness among patients with liver ailments.) *Oto-rino-laryng. ital.*, 26, 1958, 287-316.

Carefully monitored observations of over 70 patients lead the authors to conclude that there may be a causal relation between certain hepatic pathologies and various types of cochlear deficiencies. *(D. A. L.)*

Motta, G., and Profazio, A., Rapporti tra sordità professionale dei calderai e presbiacusia. (Relationships between occupational deafness of boilermakers and presbycusis.) *Oto-rino-laryng. ital.*, 26, 1958, 474-494.

After examining 140 boilermakers, gathered into groups according to age and work experience, the authors conclude that the normal degree of acoustic trauma inherent in the occupation did *not* expedite presbycusis. Medico-legal implications were drawn as a result of this and other related conclusions. *(D. A. L.)*

Padden, D., Ability of deaf swimmers to orient themselves when submerged in water. *Amer. Ann. Deaf*, 194, 1959, 317-329.

The aim of this study was to determine the ability of deaf swimmers to orient themselves when submerged. The subjects were classified into three groups: (1) congenitally deaf, (2) post-meningitis cases, and (3) deaf from other causes. A normal hearing group was tested as a control. Analysis of data reveals that the post-meningitis cases took significantly longer to surface than did subjects of the other two categories. *(H. J. O.)*

Siegenthaler, B. M., and Krzywicki, D. F., Incidence and patterns of hearing loss among an adult mentally retarded population. *Amer. J. ment. Def.*, 64, 1959, 444-449.

Audiometric pure-tone testing was performed with two groups of adult retarded institutionalized females. In one group of girls who were considered parole candidates, 17.9 per cent of 317 girls had hearing losses. The other group, consisting of girls considered uneducable and permanently institutionalized, demonstrated degrees of hearing loss in 33.9 per cent of 230 subjects. Degrees and patterns of hearing loss were analyzed and correlations computed between age, IQ, and hearing loss. *(B. B. S.)*

Subtelny, J. D., and Subtelny, J. D., Intelligibility and associated physiological factors of cleft palate speakers. *J. Speech Hearing Res.*, 2, 1959, 353-360.

On the basis of cephalometric laminagraphs and tape recordings of cleft palate speakers, and analyses thereof, 'since plosive errors were interrelated, irrespective of differing positions of articulation, the plosive manner of production is interpreted as a consistent attribute of defectiveness in cleft palate speech when an appreciable degree of velopharyngeal opening exists.' *(B. A. L.)*

Psycho-Acoustics

Kryter, K. D., Scaling human reactions to the sound from aircraft. *J. acoust. Soc. Amer.*, 31, 1959, 1415-1429.

Studies of ground observers' reactions to noise from overhead jets and conventional airplanes show no real relationship between judgments of 'annoyance' and over-all SPL or sound interference level. A better prediction of noise interference can be made using various weightings of SPL by octave bands. *(B. A. L.)*

Matzker, J., Attempt at explanation of directional hearing on the basis of very fine time-difference registration. *Trans. Beltone Inst. Hearing Res.*, No. 12, 1959. A translation of: Versuch einer Erklärung des Richtungshörens auf Grund feinster Zeitunterschiedsregistrierungen, *Acta otolaryng., Stockh.*, 49, 1958, 483-494.

Ignoring the effect of intensity differences between the two ears, a sound is perceived as coming from the direction of the ear which receives the stimulus first. With a time difference of 0.018 msec the sound appears to come from just off the median plane; with a difference of 0.6 msec it appears to come from 90° off the median plane. The author concurs in the opinion that the registration of the time difference occurs in the brain stem. On the basis of electrophysiological, psychoacoustic and neuroanatomic data, the

author attempts to explain this theory of registration of sound time differences. *(B. A. L.)*

MOUSHEGIAN, G., and JEFFRESS, L. A., Role of interaural time and intensity differences in the lateralization of low-frequency tones. *J. acoust. Soc. Amer.*, 31, 1959, 1441-1445.

Using a procedure not heretofore reported, the relative effects of time and intensity differences on lateralization were studied. Results tend to corroborate previous research findings in terms of earlier transmission time of an ear as a function of increase in intensity to that ear. Additional information is uncovered that indicates central nervous system responses are different from peripheral responses. *(B. A. L.)*

PICKETT, J. M., Backward masking. *J. acoust. Soc. Amer.*, 31, 1959, 1613-1615.

An experiment was carried out in which a 1000-cps tone was followed by a brief period of silence and then a burst of white noise of varying intensity. It was found that the white noise burst has a masking effect on the threshold of the pure-tone preceding it if the tone-noise interval is less than 25 msec. Further research on this phenomenon is indicated. *(B. A. L.)*

SMALL, A. M., JR., Pure-tone masking. *J. acoust. Soc. Amer.*, 31, 1959, 1619-1625.

'The influence of one pure tone on the threshold of another was investigated. . . . The data are discussed from the points of view of band-pass filter analog and compared to studies of previous investigators. In general the present findings represent an extension of pure-tone masking data with wider ranges of stimuli and a different method than those previously used.' *(B. A. L.)*

THURLOW, W. R., and ELFNER, L. F., Pure-tone cross-ear localization effects. *J. acoust. Soc. Amer.*, 31, 1959, 1606-1608.

'Experiments are reported on the effect of a tone in one ear on the localization of a tone in the other ear. Localization effects were systematically explored with low frequencies at 30-db sensation level, the frequency in one ear being a simple $n/1$ multiple of that in the other. With this procedure, localization effects can be obtained between low-frequency tones (below 100 cps) of widely differing frequencies. If multiples are not used, localization effects occur only within narrower frequency limits for low frequencies. Thresholds for difference between the frequencies in the two ears within which the localization effect occurs increase systematically as one goes from low- to high-frequency regions. The localization effects on a given tone cause this tone to be perceived as "pulled in" from the side location that it had when sounded alone.' *(Authors' precis)*

TOBIAS, J. V., and SCHUBERT, E. D., Effective onset duration of auditory stimuli. *J. acoust. Soc. Amer.*, 31, 1959, 1595-1605.

In terms of interaural time differences, differences in time in the start and differences in time in the endings of the stimuli are called 'transient disparity.' In addition, differences in time between similar portions of the continuing wave form were considered. From a working hypothesis that 'the relative values of transient and ongoing disparities are directly proportional to the duration over which each cue is operative, an "effect onset duration" appears to lie between two and four msec.' *(B. A. L.)*

TOBIAS, J. V., and ZERLIN, S., Lateralization threshold as a function of stimulus duration. *J. acoust. Soc. Amer.*, 31, 1959, 1591-1594.

'Measurements on experienced listeners of interaural time difference (ITD) thresholds for wide-band random noise indicates that the threshold varies systematically with duration of stimulation. In order to determine the point at which increase in duration no longer decreases ITD threshold, stimulus (noise burst) duration was varied between 0.01 and 1.94 sec. A given ITD was maintained throughout any particular burst, starting time included. All stimuli were presented at a level of 65 db SPL to each phone. The "duration" *versus* "ITD threshold" function reaches asymptote at approximately 0.7 sec, indicating that the binaural system which effects the comparison necessary for a lateralization judgment may integrate information over that period for the kind of stimulus used.' *(Authors' precis)*

TALLAND, G. A., Inter-sensory perceptual set. *Brit. J. Psychol.*, 50, 1959, 231-234.

An experimental group was compared with three control groups as to the effect of 'implicit set' on auditory perception of words. Results indicate that perceptual set can be induced as well visually as aurally, lending support to the central theory of set. *(R. W. A.)*

WANSDRONK, C., On the influence of the diffraction of sound waves around the human

head on the characteristics of hearing aids. *J. acoust. Soc. Amer.*, 31, 1959, 1609-1612.

The output of a hearing aid which was hung in an anechoic chamber during sound stimulation was compared with that of the same aid in the same position in the room but on the wearer's head. In this way effects of diffraction around the head could be measured. A large difference was found among three hearing aids, but no difference was found among the persons. *(B. A. L.)*

Rehabilitation

Belzile, M., and Markle, D. M., A clinical comparison of monaural and binaural hearing aids worn by patients with conductive or perceptive deafness. *Laryngoscope, 69*, 1959, 1317-1323.

'Within the structure of this clinical experiment, subjects with bilateral conductive deafness provide evidence of the superiority of binaural over monaural hearing aids when worn in listening conditions representing signal/noise ratios between +20 and −10 db. Subjects with bilateral perceptive deafness provide evidence of the superiority of binaural hearing aids when worn in listening conditions representing signal/noise ratios between +10 and 0. For both groups, the improvement is most evident at 0 signal/noise ratio. For both the conductive and the perceptive deafness groups, 50 per cent discrimination can be achieved in the presence of 10 db more noise while wearing a conventional monaural instrument.' *(Authors' summary)*

Brannon, J. B. Jr., and Kodman, F. Jr., The perceptual process in speechreading. *Arch. Otolaryng., Chicago*, 70, 1959, 114-120.

The speechreading performance of eight skilled speechreaders and eight nonskilled speechreaders was compared by means of a sentence test and a monosyllabic word test. The two groups were similar in their ability to speechread isolated words. An analysis of the data showed the visibility of the total movement form of a word to be the best cue in identification. Differences in size of the mouth opening, familiarity of the words and phonetic length of the words did not significantly affect recognition. Recognition of individual phonemes was related to place of articulation. As the place of articulation moved from the front to the back of the mouth, recognition decreased. The skilled group excelled in ability to speechread sentences. The authors conclude that skill in speechreading 'resides in the degree of utilization of contextual, situational, and other cues which are external to the lip movements themselves.' *(J. J.)*

Curry, E. T., Boys, F., and Stone, D. B., The effect of phenylephrine (neo-synephrine) on pure-frequency audiometric scores. *Arch. Otolaryng., Chicago*, 70, 1959, 217-220.

Phenylephrine, a nasal spray, and an isotonic saline control solution were administered to five subjects with normal hearing on alternate days. Following each administration, threshold measurements were determined for 500, 2000 and 8000 cps. It was reasoned that hearing might be improved following the use of phenylephrine due to its action in reducing edema, if present, at the orifice of the Eustachian tube. Out of 30 comparisons, six threshold improvements were noted following the use of phenylephrine and nine after using the saline solution. Fifteen threshold comparisons showed no change in hearing acuity. *(J. J.)*

Flower, R. M., Voice training in the management of dysphonia. *Laryngoscope, 69*, 1959, 940-947.

Characteristics of vocal function found frequently among patients with voice problems, general approaches to these problems, and considerations in prognosis for improvement in voice training are discussed. In terms of prognosis, the author believes that the individual's willingness to change and his ability to focus his efforts are prime factors. *(J. J.)*

Irwin, R. B., Oral language for slow learning children. *Amer. J. ment. Def.*, 64, 1959, 32-40.

The improvement of the language of the retarded child is a much more realistic goal than the correction of his specific speech defects. Concrete terms, simple everyday activities and language development practices are utilized. The ideal person to help the slow learner is the classroom teacher aided by a qualified speech clinician. Various approaches to working with the retarded, language-handicapped child are discussed. *(B. B. S.)*

Luse, E. M., The child who is slow to talk. *Elem. Sch. J.*, 60, 1959, 26-31.

The author discusses the teacher's responsibility to the child in her class who has difficulty speaking. Suggestions are offered to the teacher who wants to help the speech-delayed child in her class. Several approaches are indicated and practical information is offered. *(B. B. S.)*

MILLER, M. H., The responsibility of the speech therapist to the laryngectomized patient. *Arch. Otolaryng., Chicago*, 70, 1959, 211-217.

The author describes the mechanical larynx and the electrolarynx and discusses when the use of the electrolarynx is indicated by itself and when as an adjunct to esophageal speech. He also discusses the role and responsibility of the speech clinician and suggests that the title postlaryngectomy speech therapist be used instead of esophageal speech teacher. *(J. J.)*

ROSEN, S., and BERGMAN, M., The first 100 cases of hearing improvement in stapes mobilization—a long term report. *Laryngoscope*, 69, 1959, 1060-1065.

'This report contains a follow-up study of the present hearing of the first 100 successful cases of stapes mobilization. Eighty-three of these patients have maintained significantly improved hearing for from three to seven years. Following successful revision of seven of the regressed cases, 90 of the original 100 successful cases today enjoy significantly improved hearing.' *(Authors' summary)*

SHAROFF, R. L., Enforced restriction of communication, its implications for the emotional and intellectual development of the deaf child. *Amer. J. Psychiat.*, 116, 1959, 443-446.

The author raises the question as to what effect the enforced restriction of signing will have on the deaf child's parent-child relationship, on the deaf child's attempts to communicate with his deaf peers, and on the intellectual development of the deaf child. The author observes that communication is a basic need of every individual and where, in the case of the deaf child, oral communication is slow and laborious, other means of communication may be necessary for the emotional and intellectual growth of the child. The author presents this paper in the hope that a more tolerant attitude to the deaf child's need for language through signs to supplement his oral language may develop. The author feels there is a need for further study in this area. *(B. S. S.)*

WINGATE, M. E., Calling attention to stuttering. *J. Speech Hearing Res.*, 2, 1959, 326-335.

Stutterers recorded the same passage several times under three conditions, two of which involved having attention called to the stuttering. Significantly less stuttering was evidenced when attention was called to it. This is discussed within a theoretical framework with implications for rehabilitation. *(B. A. L.)*

WRIGHT, H. N., Binaural hearing and the hearing impaired. *Arch. Otolaryng., Chicago*, 70, 1959, 485-495.

The author discusses threshold, suprathreshold and nonperipheral factors in impaired hearing that may prevent individuals from achieving benefit from binaural amplification. *(J. J.)*

Testing and Measurement

BOCCA, E., and PESTALOZZA, G., Auditory adaptation: theories and facts. *Acta otolaryng., Stockh.*, 50, 1959, 349-353.

The clinical use of auditory adaptation is discussed. Dissimilar results for binaural, perstimulatory fatigue and monaural, poststimulatory fatigue are explained in terms of central factors (in the binaural test) as opposed to end-organ effects (in the monaural test). *(R. C. B.)*

CASTELLO, R., and BELGRANO, G., Rendiconto sul primo anno di attività del servizio di audiologia per le scuole del Comune di Genova. (First year's report of audiological services for the schools of Genoa.) *Riv. Audiol. Prat., Milano*, 8, 1958, 11-47.

The authors report the results of a group audiometry program designed to effect prevention and control of auditory deficiencies among school children in Genoa, Italy. General screening techniques were employed through the coordinated efforts of teachers, parents and school doctors. In the first year, 400 pupils out of 32,331 were subjected to special examination because of the results of the general screening. Of these, 195 were found suffering from severe auditory deficiencies. *(D. A. L.)*

DE SCHWEINITZ, L., MILLER, C. A., and MILLER, J. B., Delays in the diagnosis of deafness among preschool children. *Pediatrics*, 24, 1959, 462-468.

Histories of 48 deaf preschool children revealed that the parents usually suspected deafness before the physicians who cared for the child openly considered this possibility. By the first year and nearly always by the second year, the parents suspected deafness although they frequently complained of speech delay rather than a hearing disorder. Long delays in establishing the diagnosis occurred after the first consultation with the physician, and deafness was not adequately diagnosed in almost half the children until

after the third birthday. The importance of early diagnosis is emphasized. The authors note that the presence of a hearing loss can be detected by simple testing procedures before the first birthday and fairly complete audiograms can be obtained by a skilled audiologist by the time the child is three years old. *(B. B. S.)*

Dixon, R. F., and Newby, H. A., Children with nonorganic hearing problems. *Arch. Otolaryng., Chicago,* 70, 1959, 619-624.

The authors discuss their experience with 31 female and nine male children found to have nonorganic hearing losses. During the initial interview 39 of the 40 children were able to follow normal conversation with no difficulty. With the use of an ascending technique, normal SRT's were determined for 33 of the 40 cases. PGSR and delayed feedback measurements were used with some children to elicit normal thresholds. Consistency on serial pure-tone audiograms does not rule out the possibility of a nonorganic loss. *(J. J.)*

Flottorp, G., A comparison of the effectiveness of numbers versus PB words in voice tests of hearing. *Acta otolaryng., Stockh.,* 50, 1959, 13-25.

The author describes the advantages of PB-words over numbers (Norwegian) for use in whispered voice screening. *(R. C. B.)*

Gisselsson, L., and Sorensen, H., Auditory adaptation and fatigue in cochlear potentials. *Acta otolaryng., Stockh.,* 50, 1959, 391-405.

Reduction in the amplitude of cochlear potentials recorded from a single cochlear electrode following exposure to moderate levels of fatiguing signals was the observed variable. No decrease in amplitude was obtained for exposures below 95 db (re: human threshold). The decrease observed for higher intensities was assumed to be the result of fatigue. This decrease was not frequency-specific. *(R. C. B.)*

Hardy, J. B., Dougherty, A., and Hardy, W. G., Hearing responses and audiologic screening in infants. *J. Pediatrics,* 55, 1959, 382-390.

Auditory screening techniques are discussed that are useful in testing infants from birth to over 30 weeks. The streamlined basic test based on that used by the Ewings is described. The types of noise sources and their calibrated responses are discussed. The use of the noise makers and the subsequent actions of the children have demonstrated their feasibility as a screening device. *(B. B. S.)*

Hood, J. D., Modern masking techniques and their application to the diagnosis of functional deafness. *J. Laryng.,* 83, 1959, 536-543.

The test described by the author involves free-field thresholds to a tone of 1000 cps with an insert-type receiver in the good ear. After a quiet threshold, a narrow band of noise is introduced into the insert and the threshold for the noise determined. Then field thresholds are measured for 0, 20, 40, and 60 db SL of noise in the good ear. If the unilateral loss is truly organic, the patient's thresholds will increase with the noise. *(R. C. B.)*

Hutton, C., and Weaver, J., PB intelligibility and word familiarity. *Laryngoscope,* 69, 1959, 1443-1451.

The 15 least familiar and 15 most familiar words of the PB W-22 lists were presented to a group of 53 public school children from kindergarten to twelfth grade. The results of the study, in part, were: (1) the 15 least familiar words were less intelligible than the 15 most familiar words; and (2) intelligibility increased with age, especially for the least familiar words. The authors concluded that their data 'cast serious doubt on the use of the PB W-22 words at preschool and lower elementary school age.' *(J. J.)*

Jerger, J., and Wertz, M., The indiscriminate use of masking in bone-conduction audiometry. *Arch. Otolaryng., Chicago,* 70, 1959, 419-421.

The authors present a case study of an individual found to have unilateral otosclerosis. Use of masking sufficient to reduce the sensitivity of the better ear by 50 db resulted in reduced and false bone-conduction measurements on the otosclerotic ear. *(J. J.)*

Kodman, F. Jr., Fein, A., and Mixson, A., Psychogalvanic skin response audiometry with severe mentally retarded children. *Amer. J. ment. Def.,* 64, 1959, 131-136.

Twenty-eight severely retarded children were tested by PGSR audiometry to ascertain the feasibility of this technique with pathological children who did not respond to subjective audiometry. Two reinforcement schedules were used. Speech audiometry was also used for correlation with PGSR results. It was found that the test was effective and that speech audiometry should be used as an adjunct to PGSR testing. Other findings indicated that a statistically significant difference was not found between the PGSR thresholds obtained by the two modes of reinforcement and that the response latency

was somewhat shorter than that generally found in normal subjects. Suggestions are made for further investigations. *(B. B. S.)*

KRAUS, R. N., An evaluation of patients suspected of having noise induced hearing loss. *Laryngoscope*, *69*, 1959, 1429-1442.

The results of an evaluation of 77 United States Air Force flight-line personnel with defective hearing are reported. The evaluation revealed that 29 patients had a conductive-type, seven had a functional-type, and 41 had a perceptive-type defect. Twenty-two of these perceptive cases were unilateral. In only 19 cases was noise exposure considered to be a possible cause of defective hearing. The difficulties encountered in attempting to determine whether defective hearing in a specific patient is caused or aggravated by noise exposure are discussed. *(Author's summary)*

LIDEN, G., NILSSON, G., and ANDERSON, H., Masking in clinical audiometry. *Acta otolaryng., Stockh.*, 50, 1959, 125-136.

The use of masking noises from a specially designed noise source in routine, pure-tone audiometry is described. *(R. C. B.)*

LIDEN, G., NILSSON, G., ANDERSON, H., Narrow-band masking with white noise. *Acta otolaryng., Stockh.*, 50, 1959, 116-124.

A noise generator and variable narrow-band filter set designed for use in clinical audiometry is described. Factors influencing the masking obtained by this device are discussed. *(R. C. B.)*

LIGHTFOOT, C., BUCKINGHAM, R. A., and KELLY, M. N., A check on the Oto-Chek. *Arch. Otolaryng., Chicago*, 70, 1959, 103-114.

'A study of Chicago school children showed that the Oto-Chek screening procedure advocated by House and Glorig for use in school programs and physicians' offices is inadequate. Its inadequacy lies in its tendency to pass as normal excessively large numbers of impaired ears. Of 552 ears capable of passing the H-G test, 381 (69 per cent) were found by otological examination to be defective.' *(Authors' summary)*

MEUNARGIYA, R. V., Ob obiektivnom metodie issledovania slukha s pomoschiu elektrokardiografii. (Studies of hearing acuity with the aid of electrocardiography.) *Vestnik O. R. L., Moskva*, 20, 1958, 14-19.

In appraising the acuity of hearing, the author used the method of conditioned cardiac reflex. Pressure on the tonsil is used as an unconditioned irritant, and a signal more intense than the threshold sound or vocal irritation is applied as a conditioned stimulation. Cardiac reactions are registered electrocardiographically. The conditioned auro-cardiac reflex is formed after four to eight combinations. At the beginning it is generalized, thus giving an opportunity to record an objective audiogram. *(B. V. M.)*

OYER, H. J., and DOUDNA, M., Structural analysis of word responses made by hard of hearing subjects on a discrimination test. *Arch. Otolaryng., Chicago*, 70, 1959, 357-365.

Responses made by 400 ears to two presentations for each ear of PB test lists were analyzed with respect to type of error. A 2.8 per cent average improvement on retest was found. More substitutions than omissions occurred on both tests. Both substitutions and omissions occurred much more frequently in the final than in the initial position of the word. While there were more consonant than vowel errors, there was a greater percentage of errors on vowels. Two groups of ears were compared to determine whether the errors observed were related to type of loss. The nonconductive group made almost twice as many vowel and consonant errors and approximately three times as many errors on nasal sounds as did the conductive group, but substantially fewer errors on the consonant blends. The nonconductive group was also found to be less consistent in type of error on test-retest. *(J. J.)*

PALVA, T., Whispered voice audiometry. Clinical evaluation. *Acta otolaryg., Stockh.*, 50, 1959, 55-62.

The author compared hearing for spoken and whispered Finnish test material that had been recorded and analyzed acoustically. For listeners with normal hearing, sensitivity was improved with no loss of discrimination. Among hard of hearing listeners, sensitivity also was improved, but discrimination was affected adversely in mixed and perceptive cases. *(R. C. B.)*

ROSEN, S., BERGMAN, M. and GROSSMAN, I., Bone-conduction thresholds in stapes surgery. *Arch. Otolaryng., Chicago*, 70, 1959, 365-371.

'The changes in bone-conduction thresholds from the preoperative to postoperative tests in 155 cases of improved hearing following stapes surgery are too small to influence meaningfully the selection of cases or to constitute a "correction factor" in the prediction of results in this type of surgery. The data obtained here do not support the application

of the "Carhart shift" values to cases of stapes surgery.' *(Authors' summary)*

SATALOFF, J., and MENDUKE, H., Single and double frequency screening in school children. *Arch. Otolaryng., Chicago,* 70, 1959, 624-627.

The authors studied the audiograms of 100 children with conductive hearing losses. All had hypertrophied adenoid tissue. In this population the average loss at 4000 cps was approximately five db greater than at any other frequency. The authors conclude that the proposal of Glorig and House that children be screened at 4000 cps at a level of 15 db is very reasonable since such a procedure would have missed only five of the 100 children studied. They reject the G-H proposal to pass any child who is able to hear a 2000 cps tone at 15 db, though he failed to hear the 4000 cps tone at 15 db. In their sample the above technique would have produced 19 false negatives. They recommend the use of 4000 cps and 1000 cps as a limited frequency screening procedure. *(J. J.)*

SIMONTON, K., and HEDGECOCK, L. D., Two-frequency auditory screening: a clinical evaluation. *Laryngoscope,* 69, 1959, 1033-1040.

A total of 848 patients were tested with a two-frequency (4000 cps and 2000 cps), two-intensity (35 db and 15 db) screener. Screening was done by inexperienced personnel who were carefully instructed in the operation of the instrument prior to testing. An analysis of the audiometric data indicated that a single-frequency screen at 4000 cps is not a valid index of maximal loss. When the screening test results and audiograms were compared, significant discrepancies appeared in 18.9 per cent of the records. In a later study of 460 records errors of 10 db or more were noted in 49 cases, or 10.7 per cent. The errors appeared to be principally in the results of the screening tests and due to the inexperience of the operators. *(J. J.)*

LEAF-MOULD

Language is the soil of thought and our own especially is a rich leaf-mould, the slow deposit of ages, the shed foliage of feeling, fancy, and imagination, which has suffered an earth-change, that the vocal forest may clothe itself anew with living green. (From *The Bigelow Papers* by James Russell Lowell)

SOUND IN NATURE

Mundane nature is simply full of sound. Few events happen on the surface of our globe that do not simultaneously set up vibrations in some body or other, whether in rock or in timber, in water, or in air. Every raindrop that falls from the sky, every stream that hurries down the hillside, every wave that gathers and breaks, every branch or twig that falls from a tree, every obstructed gust of wind, every animal that steps on the solid ground or lands after a leap, sets up in the material environment, whether this be solid, liquid or gaseous, a whole series of molecular oscillations, violent or insignificant as the case may be. From their original focus these are promptly conducted in different directions, to die down in the end like the ripples from a splash in a still lake. All around us perpetual shakes and quivers are occurring. (From J. Tait, 'Is All Hearing Cochlea?' *Ann. Otol., etc., St. Louis,* 41, 1932, 681-705.)

BOOK REVIEWS

Ernest H. Henrikson, Editor

NOTE: *Authors whose books are reviewed in the* Journal of Speech and Hearing Disorders *are provided opportunity to comment, if they so desire, on the reviews of their books. Reviews and comments are published together. The Publications Board and the Book Review Editor intend this policy to facilitate informed and balanced book reviewing in the interests of the profession served by the* Journal. *(See* Journal of Speech and Hearing Disorders, *24, 1959, page 425, for the statement inaugurating this policy.)*

BAKER, HARRY J., *An Introduction to Exceptional Children* (third edition). New York: The MacMillan Co., 1959. Pp. 523. $6.50.

Introduction to Exceptional Children, currently in its third revision, is an extremely ambitious attempt to present an overview of the nature and problems of the various groups of exceptional children to be found within the school setting. As a text, the book would appear to be most appropriate for an introductory survey course in the area of special education and the topics considered would be of particular interest to the regular classroom teacher.

The book is organized into eight major sections and 32 chapters. Within these subdivisions consideration is given to the numerous kinds of exceptional children ranging from the mentally retarded to the mentally gifted and including cerebral palsy, brain injury, the various speech and hearing disorders, disorders of vision, epilepsy, lowerd vitality, slow and rapid learners, *etc.* At the end of each chapter questions and topics for further discussion are included as well as bibliographical references and some listings of films.

Dr. Baker's book serves as an ample illustration of the vast area the study of special education and the exceptional child has come to include. The problem of keeping abreast of new research throughout this area is a formidable one; even more formidable is the task of translating this research into the concise statements a survey text requires without oversimplifying or sacrificing accuracy. Unfortunately, Dr. Baker's book does not adequately meet these requirements; and though a large number of topics are treated, the coverage lacks depth and in many instances is inaccurate.

Of particular concern to the speech and hearing clinician are the three chapters (21-23) relative to problems of hearing and the two chapters (24-25) dealing with the processes and disorders of speech. Within these few chapters Dr. Baker has attempted to summarize basic physiological and anatomical information and even some acoustics in addition to discussing the numerous specific speech and hearing problems. As a consequence, specific treatments tend to be overly brief, with only a few paragraphs devoted to each of such complex problems as stuttering, articulation, cerebral palsy and cleft palate. More important than brevity, however, is the fact that these discussions contain, in many instances, statements that are misleading or erroneous.

It is not quite accurate to state that 'the decibel is . . . the amount of difference which is barely discernible between two intensities,' or to indicate that a wad of cotton or a rubber earplug is sufficient to eliminate hearing in one ear. Similarly, it is misleading to state that conductive disorders cause 'deafness,' or that through speech training 'totally deaf children' are 'able to converse in normal speaking voices,' or that the effects of loud explosions or other kinds of acoustic trauma are primarily in the outer and middle ear.

In Dr. Baker's treatment of speech problems a number of instances may also be cited in which information presented is inaccurate or misleading. The inclusion of speech problems in the section dealing with 'Physical Disorders and Defects' would appear to be an improper emphasis since, by far, the majority of speech problems encountered in the schools are not attributable to organic conditions. Of equal concern are such statements as, 'While there is some evidence that

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stuttering runs in families the fundamental cause may not be hereditary but due to constant imitation of the stuttering parent.' It would be unfortunate if the student gleaned from this that stuttering is an imitative disorder. This notion has long been discarded in speech pathology. Elsewhere in the chapter Baker defines 'dysphasia' as 'disorder of articulation,' apparently confusing the term with 'dysarthria.'

At one point, the author, in discussing procedures for examination of speech, includes the following paragraph:

> The speech teacher or speech correctionist examines for the many specific defects in the speech itself and in this examination process she is immediately aware of any anatomical abnormalities from the type of speech disorder. She refers such anatomical abnormalities to the speech pathologist who may advise or perform corrective surgery when necessary (p. 389).

This is a serious misrepresentation of the roles of both the speech correctionist and the speech pathologist. Speech correctionists do not pretend to be 'immediately aware' of anatomical abnormalities simply on the basis of a speech examination. Nor do speech correctionists or speech pathologists perform any kind of 'corrective surgery' or make medical diagnoses.

These errors and others, such as identifying optometrists as medical doctors and indicating that Helen Keller was congenitally deaf and blind, greatly reduce the usefulness of the text in that they require a concerted vigilance on the part of student and instructor to sort them out. In the use of footnotes and references there is again a lack of fastidiousness. References were found to be incorrect in several instances and to have been omitted at other times when they would have been appropriate.

Photographs and diagrams in the book are not given page numbers and are not cited in either the table of contents or the index. This becomes extremely inconvenient in a number of instances. In the section of hearing, for example, the author discusses anatomy and physiology and makes reference to a diagram of the ear but does not indicate where this diagram is to be found in the text. The diagram appears some 31 pages after the discussion, without labeling of anatomic parts, so that any attempt to use the diagram in conjunction with the author's presentation is virtually impossible. In general, diagrams are not advantageously located with respect to the discussion to which they presumably refer.

In summary, this book, while extremely ambitious, seems deficient in terms of both accuracy of report and style of reporting. Though there is certainly benefit in having a book which presents, in a concise, cumulative way, the status of present knowledge in the broad areas of special education, the dangers of inaccuracy and oversimplification inherent in such an undertaking must be met with more precision and care than is present in this text.

GERALD M. SIEGEL
University of Kansas

Author's Comment: The author appreciates the opportunity to examine the review in advance of publication. If he is able to read between the lines, he detects some degree of resentment upon the part of the reviewer that any individual in an allied field should presume to sketch as much as a brief outline outside of his own specialization.

In his professional activities, the author has close working relationships in providing psychological service for all types of handicapped and exceptional children in a large metropolitan city. As a past president of the Council for Exceptional Children, as chairman of a subcommittee on the education of exceptional children for a White House Conference on Children and Youth, and as a summer school instructor in several state universities, he has had many opportunities to confer with recognized leaders in all of these special fields.

This text is designed primarily as an introduction to the very broad area of exceptional children so as to interest an increasing number of potential teachers to qualify where shortages have always been critical. As such, it does not presume to cover any area as completely as would be expected after specialization has begun.

The author has been aware of many disagreements and differing fields of thought among the leaders in many types of exceptional children. If by chance he happens to mention some at the neglect of others, criticism is inevitable, and the halo effect becomes quite widespread.

The reviewer seems to be unaware that in the manufacture of a book there are 'separations' of 32 pages and between them the illustrations must appear, usually without page numbering but placed as close as possible to the context.

HARRY J. BAKER
Detroit Public Schools

BRYNGELSON, BRYNG, and MIKALSON, ELAINE, *Speech Correction Through Listening*. Chicago: Scott, Foresman & Co., 1959. Pp. 126. $1.60.

Here is a goldmine of materials for work with articulation problems, whether this work is done by a speech clinician in a speech correction program or the classroom teacher in a speech improvement program. The first portion of the book presents background information on ear training and speech development adapted from Charles Van Riper's seven retraining steps for articulatory disorders. While the material is written for the classroom teacher, it also provides an excellent summary and rationale for speech clinicians. Commonly misarticulated speech sounds are introduced to the children through sound stories which present the sounds in isolation. While the stories are excellent for children in the middle grades, this reviewer finds them long and complex for primary grade children.

The outstanding feature of this book is the collection of activities for isolating the sound, identifying the error sound, strengthening the sound, *etc*. Over half of the book is devoted to 137 activities which can be used and reused for many different aspects of the speech improvement and clinical speech program. The activities are adaptable to primary and intermediate grades. Although listening is emphasized, there are ample activities devoted to speaking situations in which the children participate actively. Every speech clinician will want a copy of this book at her fingertips, as well as recommending it to classroom teachers interested in speech improvement.

WILBERT PRONOVOST

Boston University

Editor's note: Dr. Bryngelson commended the selection of the reviewer but had no comment to make on the review.

BUROS, OSCAR K. (Editor), *The Fifth Mental Measurements Yearbook*. Highland Park, New Jersey: The Gryphon Press, 1959. Pp. 1292. $22.50.

Readers of this journal have an interest in this monumental addition to a distinguished series of volumes both because of their direct use of educational and psychological tests and because test scores crop up constantly in the records of students and clients with speech and/or hearing problems. Buros' 'yearbooks' are not annuals; this one covers 1952-1958. They attempt to list all commercially available tests and all books on measurement in the English language. This edition includes reviews of a few older tests; of the tests listed here for the first time, nearly all are reviewed by at least two persons. For each test there is a rather complete bibliography.

Speech and hearing specialists will not become test experts by reading these 1300 pages. Reading the reviews of a particular test will not tell them all they need to know about that test. How then can professional workers in speech find Buros' MMYB useful? They will find it helpful to read the relevant reviews when they feel that they need a better understanding of the tests being used by fellow professionals—the administrators who typically give achievement and aptitude tests and the clinical psychologists who provide case work-ups for many of the persons with whom the speech clinician deals. Many speech clinicians will have occasion to sit in on conferences to plan for group testing and clinical testing programs in schools and in clinics. Although there are only two tests in this volume under the rubric of Speech, there are other tests concerned with Hearing, Listening Comprehension, and Oral Reading, which are clearly in the domain of the speech specialists. With the Fourth MMYB and the Fifth MMYB at hand in his personal or institutional library, the speech and hearing specialist will have ready access to critical evaluations of nearly all currently available tests. Buros himself would agree that this competently prepared and comprehensive volume provides only supplementary help to those who wish to learn more about the complex field of educational and psychological measurement. We need to study the original sources, the tests and their manuals; even before that, we need to have sound training in psychometrics or have access to advisers who are so trained.

HAROLD SEASHORE

The Psychological Corporation

Author's Comment: Many thanks for sending me an advance copy of Dr. Seashore's review of *The Fifth Mental Measurements Yearbook*. Needless to say, I am most pleased that you are running such an appreciative review. I certainly do not wish to add any comments. The review will help motivate us to do a better job in preparing the Sixth Mental Measurements Yearbook.

OSCAR K. BUROS

Rutgers University

DIEHL, CHARLES F., *A Compendium of Research and Theory on Stuttering*. Springfield: Charles C. Thomas, 1958. pp. 314. $9.75.

This book contains 193 abstracts of articles about stuttering and nonfluencies of the nor-

mal speaker; materials from texts and unpublished studies were not considered. Publication dates of the articles range from 1915 to 1957, with about 15 per cent coming before 1936 when the *Journal of Speech Disorders* was first published. Over half of the 193 articles appeared in that journal and its successor, the *Journal of Speech and Hearing Disorders.*

Each abstract is divided into four sections: purpose, experimental design, summary, and conclusions. Each abstract was placed in one of the following five categories (the Arabic numerals indicating the number of abstracts in each category). I. History, 2; II. Symptomatology, 39; III. Etiology—Physiological, 64; IV. Etiology—Psychological, 41; and V. Therapy, 47. At the end of each unit except I History, related references are given. There is also a general reference list and a short foreign language reference list at the end of the book. In all there are 364 references. Within a unit similar articles, *e.g.*, brain-wave studies, have been placed together. Unfortunately, one must skim the book to determine such groupings as no information about the individual abstracts is given in the table of contents.

According to the author, the '. . . publications abstracted were not necessarily selected on the basis of their excellence, but rather as being representative of certain areas of research and theory.' However, certain areas—such as the relationship of stuttering to the spoken or written word, *e.g.*, sounds, word length, *etc.*—seem to have received much emphasis. Areas such as severity ratings were treated much less exhaustively. Admittedly, there are space limitations forcing some lack of completeness and representativeness. However, space could have been saved by eliminating abstracts based on abstracts (see p. 205 for this questionable procedure) and by combining the summary and conclusion sections. Some conclusion sections were scarcely more than a summary of the summary of results. This combining procedure would also have made the style of the abstracts more similar as hypotheses are sometimes in the summary and sometimes in the conclusion.

The reviewer compared some of the abstracts with the original publications. Generally, the abstracts were concise, accurate, and clearly written. Although few would agree on exactly how much the original article should be condensed, an adequate job seems to have been done in this respect. The 'fat,' so to speak, was fairly skillfully removed to save most of the 'meat.' There are rare instances where the abstracts seem ambiguous; some ambiguity can be traced to the original article, however. One instance was noted where there was a clear-cut inaccuracy in an abstract of an article: D. M. Davis, 'The Relationship of Repetitions in the Speech of Young Children to Certain Measures of Language Maturity and Situational Factors: Part I,' *Journal of Speech Disorders*, 4, 1939, 303-318. The abstract states that the purpose is 'To determine if the speech of young children is affected by the factor of age and certain situational factors such as labeling.' These are not the major purposes of the study. Furthermore, situational factors are considered in another article by Davis, not the one in question. The effect of labeling on repetitions has never been directly investigated by Davis as far as the reviewer knows.

In the beginning of the book is a section entitled 'How to Use the Compendium,' in which a few pages are devoted to assisting the untrained reader in evaluating research; concepts such as sampling, reliability, *etc.*, are discussed briefly. In this section, the author warns the beginning student to start with Unit I, History, not Unit IV, Therapy. This warning seems to stem from the possibility of uncritical acceptance of certain ideas, perhaps such as the use of distractions like syllable tapping for therapeutic purposes. It would seem that this book has some dangers for the beginning student who is reading without guidance. However, where guidance is provided, as would be the case in a course on stuttering, this book could certainly be used advantageously by the student.

Although the author suggests that the beginning student start with Unit I and read forward, most persons would probably not read the abstracts in their entirety or in succession unless required to do so. Reading successively is obviously not necessary in a book like this. Abstracts that are especially pertinent or interesting to a person will tend to be read and the others will tend to be skimmed or omitted.

In spite of his previous criticisms, the reviewer feels that this book should be of considerable value, especially to persons with more than a rudimentary knowledge of stuttering and with a knowledge of the limitations of abstracts. Truly a great amount of material has been condensed and there are many helpful references. Persons doing research in the area of stuttering should find the book especially useful.

DALE LUNDEEN
Northern Michigan College

Editor's note: This review was sent to the author but no comment was submitted.

DUBRUL, E. LLOYD, *Evolution of the Speech Apparatus*. Springfield: Charles C. Thomas. 1958. pp. 103. $4.75.

This is a Monograph in American Lectures in Anatomy, edited by Otto F. Kampmeier. It was simultaneously published in the United States, Canada, and England. Although the first portion of the book assumes a content background in the study of evolution, the writing style of the author and his good use of examples enables the reader not knowledgeable in the area of evolution to assimilate quite easily the concepts presented. He clearly states specific principles of evolution which subtly develop for the reader an evolutionary attitude for later application to the study of the human speech mechanism.

The concepts of *general reduction of repetition* and *special reduction of repetition* are the basic evolutionary themes considered. These concepts are traced through various species from unicellular bodies to the complex organism of man. Throughout this chronicle of evolution, the author has been able to inject a sense of excitement and anticipation of the final end product—speech in man!

Although the author points out that structure determines behavior, there are times in his discussions when it is difficult to determine whether the presence of a specific set of structures has determined the existence of a function, or whether the functional use of a set of structures has influenced its later appearance. But the impression of a dynamic interaction between structure and function remains paramount and sets the stage for discussing the importance of postural changes as a factor in the ultimate development of speech.

The progression from horizontal to vertical posture and the reduction in size and number of appendages directly influence the prehensile and masticatory functions of the mandible and tongue. Freed from many such feeding responsibilities, these structures become available for use in communication. Similarly, progress to the vertical posture has created different physiological and positional relationships among the larynx, esophagus, pharynx, and nasal and oral cavities, thereby permitting the productions of sounds as they are now perceived.

Concomitant with these changes in peripheral structure are changes in brain morphology in terms of expansions of various lobes of the brain which differentiate man from other species. Studies are presented of cell counts and cell distributions and clusterings suggesting the 'quantitative loss in the mesencephalic nucleus of the trigeminal nerve concomitant with the dwindling in mass and function of the peripheral masticatory elements.' The importance of the proprioceptive 'feedback' system is related to the development of new behavior patterns and adaptations such as is found in speech production.

It becomes immediately apparent that much knowledge and effort was brought to the writing of this monograph. The many illustrations throughout demonstrate the writer's concern for facilitating an understanding of his ideas. His lengthy bibliography further demonstrates not only the background and documentations of the book but provides ready references for the more interested reader. Although this book would not provide the speech clinician any new clinical procedures, it does provide a refreshing and stimulating view of the mechanism of speech and communication. One cannot but wonder what the future may hold for our present speech and communication patterns as the never-ending evolutionary process unfolds.

GEORGE H. SHAMES
University of Pittsburgh

Author's Comment: I do not quite understand how 'the functional use of a set of structures has influenced its *later* appearance,' but no matter. As you suggest, this work was not aimed at clinical features of speech but was an attempt at an entirely new way of getting at structural evidence for the evolutionary change in behavior. I do believe, however, that serious clinical students can get deeper insight into speech mechanisms by such studies in basic biology. Thank you so much for your courtesy in allowing me a preview of your review.

E. LLOYD DUBRUL
University of Illinois

SMITH, GENEVIEVE W., *Care of the Patient with a Stroke*. New York: Springer Publishing Co., Inc., 1959. Pp. 148. $2.75.

Many professional rehabilitation workers spend a great deal of time answering questions, counseling the aphasic patient's family, and discussing many of the problems covered in this comprehensive and informative handbook. The material which has been developed by the author stems not only from personal experiences involved in the home care of a family member, but also from additional information gathered from the families of other aphasic patients. Much has been written about the rehabilitation of aphasic patients but this material is often too technical to be useful to the layman. There has been a crucial need for accurate nontechnical material in this

area. This handbook makes a significant contribution by presenting material which is clearly readable, constructively illustrated, and easily understood.

The handbook is presented in two parts. The first discusses the patient's return to family and community living. Some of the most frequently encountered problems in readjusting the family unit and continuing the rehabilitation program in the home are outlined and flexible, practical solutions to these problems are offered. The second part contains detailed suggestions about diet, massage, exercise, and activities of daily living. Not only will the aphasic patient's family find this handbook an invaluable aid but many professional workers will find it an excellent source book.

RUBY MITCHELL SIMMONS
University of Washington Hospital

Editor's Note: This review was sent to the author but no comment was submitted.

REHABILITATION COUNSELING

The College of Education of the State University of Iowa announces the availability of a monograph, 'Critical Counseling Behavior in Rehabilitation Settings' by Dr. Marceline Jaques, now at the School of Education, University of Buffalo. It reports findings obtained by using the Critical Incident technique with 404 rehabilitation counselors in 20 states. The foreword for it was written by Dr. Wendell A. Johnson. This investigation and the publication of the final report were supported, in part, by a research grant from the Office of Vocational Rehabilitation, Department of Health, Education, and Welfare, Washington, D. C. Dr. Jaques was the principal investigator and Dr. John E. Muthard was the project director for the study. Counselors in the state-federal programs and other agencies or persons on OVR mailing lists will secure copies of this report directly from OVR. Copies can be obtained without cost by writing the project director at the College of Education, State University of Iowa, Iowa City, Iowa.

COMING IN THE AUGUST JOURNAL

1. 'The Development of Stuttering: I. Changes in Nine Basic Features' by Oliver Bloodstein.
2. 'A Moveable Bulb Appliance to Assist in Palatopharyngeal Closure' by Samuel G. Fletcher, Richard C. Haskins and James F. Bosma.
3. 'Test-Retest Consistency of Clinical Hearing Aid Tests' by Freeman McConnell, Eileen Fine Silber and Douglas McDonald.
4. 'Quality Judgment with Respect to Hearing Aid Selection' by Janet Jeffers.
5. 'Childhood Nonorganic Hearing Loss' by George J. Leshin.
6. 'Urban School Services for Children with Hearing Loss' by Helen M. Wallace.
7. 'Double-Frequency Auditory Screening in the Public Schools' by Max C. Norton and Elizabeth Lux.